PLATTE RIVER
FORUM FOR THE FUTURE

Nebraska Natural Resources Commission

State Water Planning and Review Process

January 1985

STATE OF NEBRASKA

Robert Kerrey, Governor

NEBRASKA NATURAL RESOURCES COMMISSION

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To Those Who Took Part
and
To The Reader —

It is not unusual in astronomy, nature, or our everyday world for several somewhat uncommon but related events to occur simultaneously or within a short time span which require particular attention. Occasionally such phenomena produce exceptional results. Such were the events that encouraged the Nebraska Natural Resources Commission in 1982 to sponsor the Platte River Forum for the Future in considering the competing demands for Platte River water.

These related events include: a Nebraska Supreme Court decision that interbasin water transfer is not unconstitutional; a proliferation of applications from water project sponsors for uses of Platte River water; new federalism that requires state cost-sharing for water project development; the federal designation of a portion of the Platte River Valley as a critical habitat area for the whooping crane and the establishment of the Platte River Whooping Crane Habitat Maintenance Trust; and, a desire on the part of State officials to utilize a conflict resolution, consenus building process to form a basis of support for water use decisions.

The Platte River Forum brought together individuals and representatives of organizations with a wide array of interests. Through a systematic process we built a mathematical computer model that represented the river system as we perceived it. Though we didn't always agree, the range of debate was narrowed and conducted on a more informed basis. In many instances the focus of difference was sharpened and often overcome. For perhaps the first time "environmentalists" and "developers" were brought together in a live-in dormitory-laboratory environment where they became personally acquainted and searched for reasonable compromise face to face. And, for the "blood, sweat, and tears" that this group shed, I am truly grateful.

The value of the Platte River Forum is a question yet to be answered. The mathematical model continues to be updated as improved data is available. It is an increasingly viable management tool for use in policy-level decisionmaking. On a less tangible but equally important level, people across the state now routinely accept the notion that we must think of the river as a system and not only of our particular interest. It is also understood that we must look toward the middle ground in building consensus as we move from the status quo to more dynamic decisionmaking.

Our efforts in the Forum may never be recognized as a benchmark accomplishment but to the extent they may contribute to a more rational, informed approach to understanding the river and conflict resolution on proposed changes, we take some satisfaction.

Sincerely,

Verlon K. Vrana

Verlon K. "Tony" Vrana
Chief, Planning Division

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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Chapter 1
INTRODUCTION TO THE PLATTE RIVER FORUM FOR THE FUTURE

The Platte River historically has been one of the major sources of water supply for a large array of man's activities in Nebraska. With increasing activity came greater and greater demands for the river's water. At times the demands exceeded the seasonally-limited supply, so proposals to store and use the surplus flows of winter and spring were developed. A proposal to transfer some of that water out of the Platte basin produced a decision by the Nebraska Supreme Court and action by the legislature that provided the legal basis for future interbasin transfers. This led to greater competition for the waters of the Platte.

One of the results of all this activity has been costly and time consuming litigation that has not yet been resolved. Eventually it was recognized that litigation does not necessarily result in the "best" solution for all potential users of the Platte nor a solution that is in the best interest of the state as a whole.

The competing proposals would all be major water projects. In the past the federal government has been primarily responsible for planning and financing water resource development on this scale. However, recent administrations have advocated a reduced role for the federal government. They have taken the position that states should be more active in planning and funding water resource development within their own boundaries.

Increasing concern about the competition and conflict over Platte River water plus the probable need for greater state financial commitment in water resource development prompted both public officials and private citizens to seek some means to resolve these issues. This led the Natural Resources Commission (NRC) to initiate and conduct a conflict resolution process called The Platte River Forum for the Future.

Purpose of the Forum

The fundamental objectives of the Forum were twofold. One was to provide a vehicle to develop and improve the general understanding of the Platte River. Another was to provide a means for developing a consensus among those responsible for decisions concerning use of the Platte River waters. This consensus then could have provided the basis for establishing state priorities for cost-sharing on federal feasibility studies and water development projects.

Understanding the Platte River requires insight into the physical characteristics of the river and the agricultural, municipal, industrial, fish, wildlife, and recreational uses of it. The river, the land in the valley, the groundwater under it, and the plants and animals dependent on them form a complex system vital to the people living, working and visiting in the area. Considering the river as a system can lead to greater recognition by competing interests of the effect of their proposals for water use on others and what others' proposals mean to them. Better understanding by all concerned is a necessary first step for resolving conflicts among competing users or potential users of the Platte River.

Making plans and setting priorities also requires knowledge of how the river operates as a system. Greater state involvement in planning and financing water projects makes better understanding of the system even more vital.

Contributors to the Forum

The NRC and many others realized that better means of assigning priorities and making decisions was needed. The search for a method to resolve the conflicts led the NRC to the process that was eventually named the Platte River Forum for the Future. The Governor's Office and key legislative committees aided the NRC in reprogramming state funds for the project. Funds were also contributed by the Platte River Whooping Crane Habitat Maintenance Trust and four Natural Resources Districts: Central Platte, Tri-Basin, Little Blue, and Upper Big Blue. Support for the Forum was provided by:

Game and Parks Commission
Department of Economic Development
Department of Water Resources
Water Resources Center — University of Nebraska-Lincoln (UNL)
Conservation and Survey Division — UNL
Department of Agricultural Engineering — UNL
Department of Agricultural Economics — UNL
Department of Civil Engineering — UNL
Nebraska Association of Resources Districts
Public Advisory Board

Many organizations and individuals also contributed to the process at their own expense.

Description of the Process

The process that was used in the Platte River Forum is the internationally recognized Adaptive Environmental Assessment (AEA) Process described in *Adaptive Environmental Assessment and Management,* (C.S. Holling, 1978).

THE BASIC PROCESS

The basic elements of the AEA Process are a series of alternating workshops and research periods. In the workshops, problems are defined and alternatives are explored and evaluated. During the research periods, data and methods are researched and refined. The process is begun with a small group meeting to define problems and objectives and list potential participants in the workshops. A project leader provides assistance in the initial stages and is later joined by a technical workshop staff called a "core team." The participants in the workshops can be experts in related areas, advocates of various interests or projects, managers, planners, policymakers, and others.

The process is structured to resolve or produce better understanding of conflicts. Therefore the task of the project leader is to encourage free and open discussion at the initial workshop to develop workable and flexible ideas. The workshop group identifies factors that are important in decision making and the relationships between them that describe the physical system as it is perceived by the workshop participants. This information is quantified and programmed by the core team into computer models that use mathematical equations to represent actual systems and processes. As relationships between factors are expressed in numbers, it is likely that the need for new data to improve them will become apparent. Consequently the workshop is followed by a research period to gather the data and refine the relationships. When the model is constructed and refined to the satisfaction of the participants, alternative scenarios can be evaluated and recommendations made.

The AEA process has been used to study a wide variety of problems across the United States. Projects that have used it include the Truckee-Carson River Quality Assessment Project in western Nevada, the Sacramento/San Joaquin Fish and Wildlife Management Project in central California, the North Dakota Wetlands Project, and the Beluga River Area Coal Development Project in Alaska. Each of these projects was successful in establishing communication among interested parties, increasing the understanding of issues involved, identifying needed data and research and providing a means to discover realistic solutions to problems.

THE MODIFIED PROCESS

The Platte River Forum was originally structured to follow the AEA process with only slight modifications. An early change was the addition of a team of experts with a broad range of technical backgrounds from six Nebraska agencies. The task of the Nebraska core team was to become familiar with the computer model as it was developed, so it could be used on a continuing basis once the AEA process was completed.

A scoping meeting to delineate the issues and the potential participants took place during June 1982. A week-long workshop was held in Grand Island in August 1982. After that workshop the NRC decided to make a major change in the process by shifting responsibility for revising and operating the computer model to the Nebraska core team. In making the transition, the federal team helped expand and improve the model. The revised model was demonstrated and baseline results were presented for discussion at a second workshop which was held in November 1982. Participants suggested further revisions and possible scenarios for future development.

Following this workshop the AEA team began preparing a report documenting and describing the computer model. The report was completed in March 1983.

The Nebraska team continued to refine the model by identifying needed data, collecting available data and including suggested revisions approved in small work group meetings. In a November 1983 meeting of the original workshop participants, observers and others, model revisions were explained and relevant results of several scenarios were displayed. Policy level officials were invited to a meeting in early December where the same information, in condensed form, was presented.

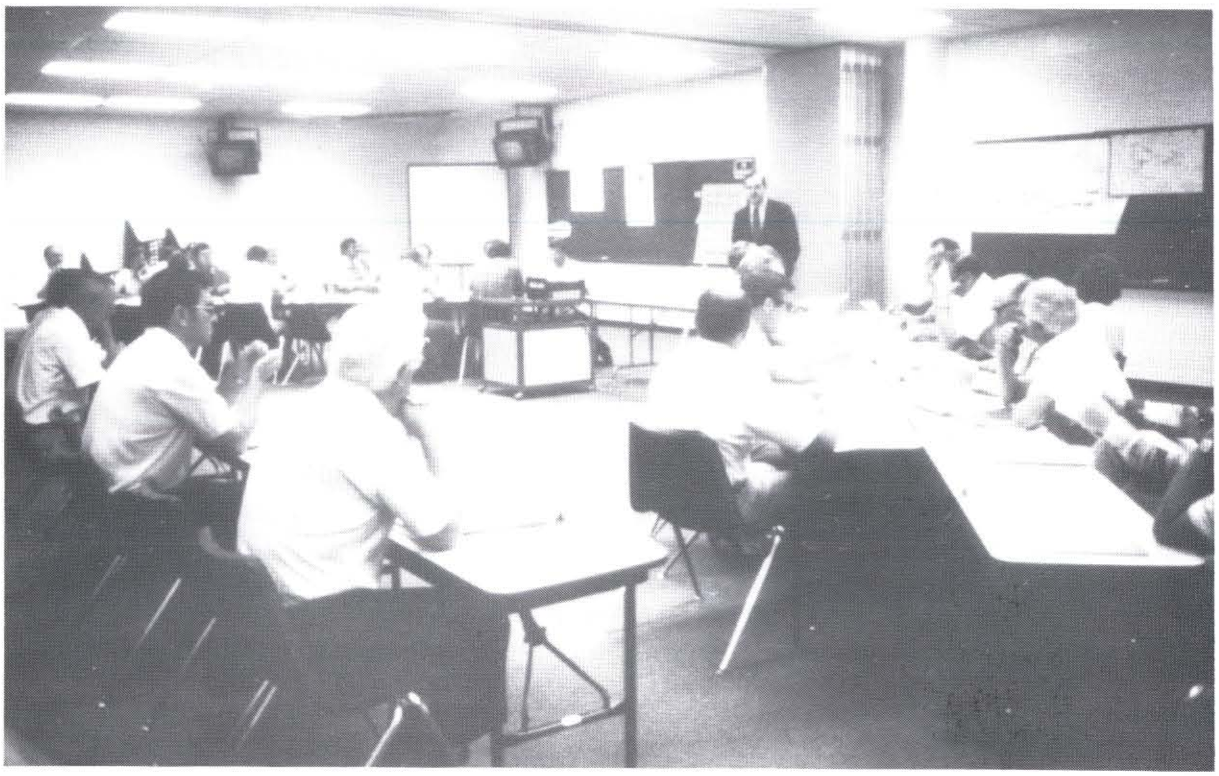


Table 1

PLATTE RIVER FORUM PARTICIPANTS

State

Mike Jess — Department of Water Resources
Tony Vrana — Natural Resources Commission
Bob Gifford — Natural Resources Commission
Bill Bailey — Game and Parks Commission
Wes Sheets — Game and Parks Commission
Dave Jensen — Dept. of Environmental Control
Cliff Summers — Department of Health
Chris Beutler — Nebraska Legislature
Maurice Kremer — Nebraska Legislature
Howard Lamb — Nebraska Legislature
Jack Hart — Governor's Office

Federal

Chuck Frith — Fish and Wildlife Service
Fred Otradovsky — Bureau of Reclamation

Natural Resources Districts

Jay Bitner — Upper Big Blue
Kent Miller — Twin Platte
E. Gerald Erickson — Lower Platte North
Ron Bishop — Central Platte
Dave Mazour — Little Blue
Jerry Wehrspann — Papio
Bill Umberger — Tri-Basin

Power and Irrigation Districts

Ralph Knepper — Central Nebraska Public Power and Irrigation District
Bob Peterson — Nebraska Public Power District
Vernie Laverach — Enders

Environmental Groups

Bob Warrick - Sierra Club
Keith Harmon — Wildlife Management Institute

University of Nebraska-Lincoln

Vince Dreeszen — Conservation and Survey Division
Don Hanway — Department of Agronomy
Jim Stubbendieck — Department of Agronomy

Urban, Management and Production Interests

Joe Jeffrey — Nebraskans for Responsible Water and Wildlife Management
Clayton Lukow — Livestock Interests
John VanDerwalker — Platte River Whooping Crane Habitat Maintenance Trust
Keith Sinor — City of Grand Island
William Holland — Lower Platte Basin Interests

Chapter 2
THE FORUM PROCESS

The Platte River Forum for the Future created a climate conducive to thoughtful discussion and resulted in better understanding among the participants of their positions and of the Platte River system. This understanding and environment for negotiation contributed to efforts to reach a settlement, but the most permanent product may have been the Forum process itself. It is a process that provides the setting and capability to discuss, define and simulate conditions on the Platte River system to promote resolution of conflicts. It has been structured so it can be maintained and used again at any time in the future.

The process is composed of two elements. One is a computer model designed to simulate the physical characteristics of the Platte River and its relationship with agriculture, wildlife, municipalities, industries, and the economy of the area. The other element is the people who define it, make it work, and use its output. The people and model together provide a process for exchanging ideas, discussing issues and exploring alternatives for management of the river.

The People

The Platte River Forum for the Future benefitted from the services of many people with a broad range of backgrounds, interests, and knowledge. They served a wide variety of functions including direction, leadership, and management of the process; development of the computer model; sharing political insight; and discussion, negotiation and resolution of issues, large and small.

Direction for the Forum was provided by the Governor and the NRC. Management was provided by the Chief of the NRC Planning Division, Verlon K. Vrana, and the Commission staff.

Leadership in development of the model and the Forum Process was initially provided by the Western Energy and Land Use Team specially trained in the Adaptive Environmental Assessment Process. Eventually the leadership role was assumed by the Nebraska Core Team, who refined the model and used it to demonstrate the capabilities of the process. Members of the core team are listed at the bottom of the page.

Discussions and negotiations among parties with an interest in the waters of the Platte River, with input from some of the officials responsible for state decisions on proposed activities, took place at a series of meetings and workshops. These people represented government agencies and private organizations with a broad range of interests, as shown in the list of workshop participants in Table 1.

NEBRASKA CORE TEAM

Dr. James Gilley	UNL, Department of Agricultural Engineering
Dr. Martha Gilliland	UNL, Department of Civil Engineering
Dr. William Powers	UNL, Water Resources Center
Dr. Raymond Supalla	UNL, Department of Agricultural Economics
Mr. Ralph Cady	UNL, Conservation and Survey Division
Mr. Dennis Gilbert	UNL, Water Resources Center
Mr. Lee Becker	Nebraska Department of Water Resources
Mr. Joseph Gabig	Nebraska Game and Parks Commission
Mr. Richard Kern	Nebraska Natural Resources Commission
Mr. Stuart Miller	Nebraska Department of Economic Development

The Model

The Forum model was developed to produce information that would improve understanding of the system and provide the basis for making decisions on the most acceptable uses of the Platte River and surrounding area. It produces estimates of the changes in future conditions that could be caused by the continuation of current trends or by proposed management or development alternatives.

The area modeled includes the Platte River and lands that are affected by the river and by proposals to use the water of the river. The modeled area is shown in Figure 1. It includes the Platte River basin from Julesburg, Colorado (South Platte River) and Keystone (North Platte River) in the west to Louisville in the east. The area is divided into eight sections at the location of stream gaging stations. The sections are:

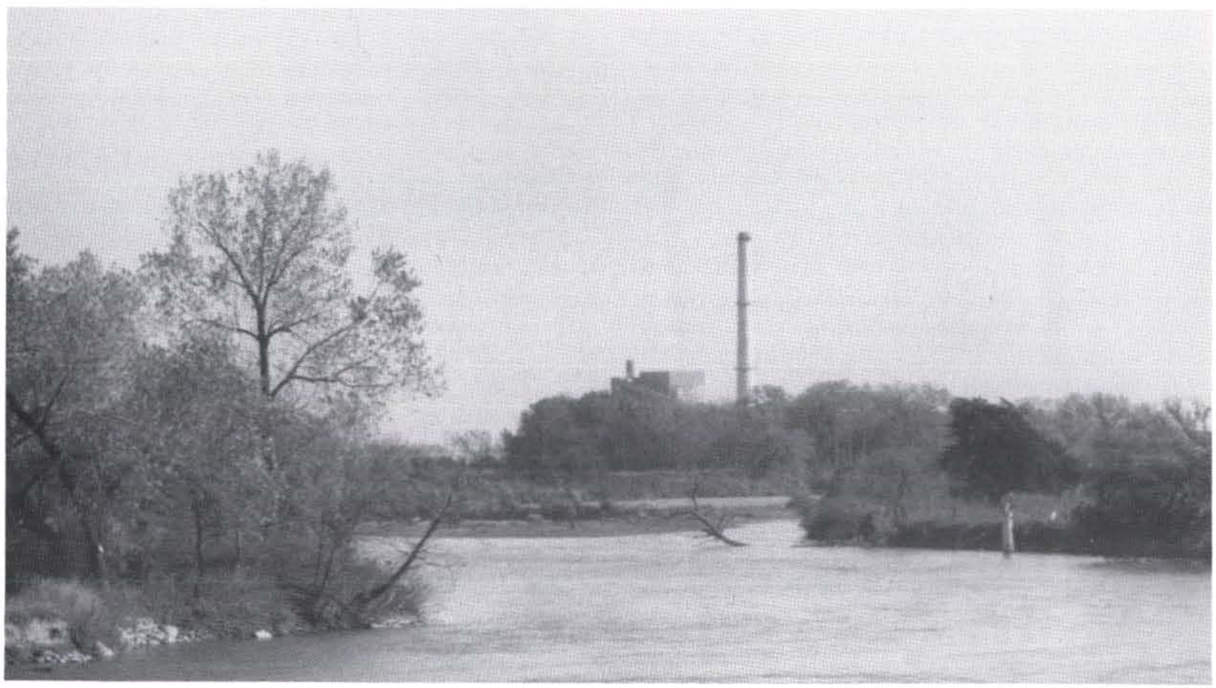
(1) Julesburg to North Platte
(2) Keystone to North Platte
(3) North Platte to Brady
(4) Brady to Overton
(5) Overton to Grand Island
(6) Grand Island to Duncan
(7) Duncan to North Bend
(8) North Bend to Louisville

Three areas outside of the basin are included in the modeled area. These three are the proposed Big Blue (Landmark), Little Blue (Catherland) and Enders project areas.

A model is a representation of the characteristics of an object, system or process. In this case it is a mathematical representation of the Platte River and associated systems. These systems are described in the model by numerical files of historical data and hundreds of equations that define the relationships of all the factors to one another as they change over time. The relationships that are expressed by these equations were first defined by the participants in the meetings, put into words and numbers by the modelers, and fine-tuned to the satisfaction of the participants by running the model and making adjustments until it would satisfactorily duplicate the past 20 years.

All actions were to be simulated over time so selection of an appropriate time increment was important. The basic time segment selected for the model was one month; that is, most of the indicators are updated on a monthly basis. The simulation period may be as short as a month or as long as 50 to 100 years in one-month steps.

Construction of the Forum model was begun by describing potential actions and indicators. Management alternatives (actions) and measures of performance (indicators) that would show the effectiveness of the actions were identified during discussions in meetings and workshops. These provided the basis for dividing the model into six submodels: surface water, groundwater, agriculture, wildlife/recreation,



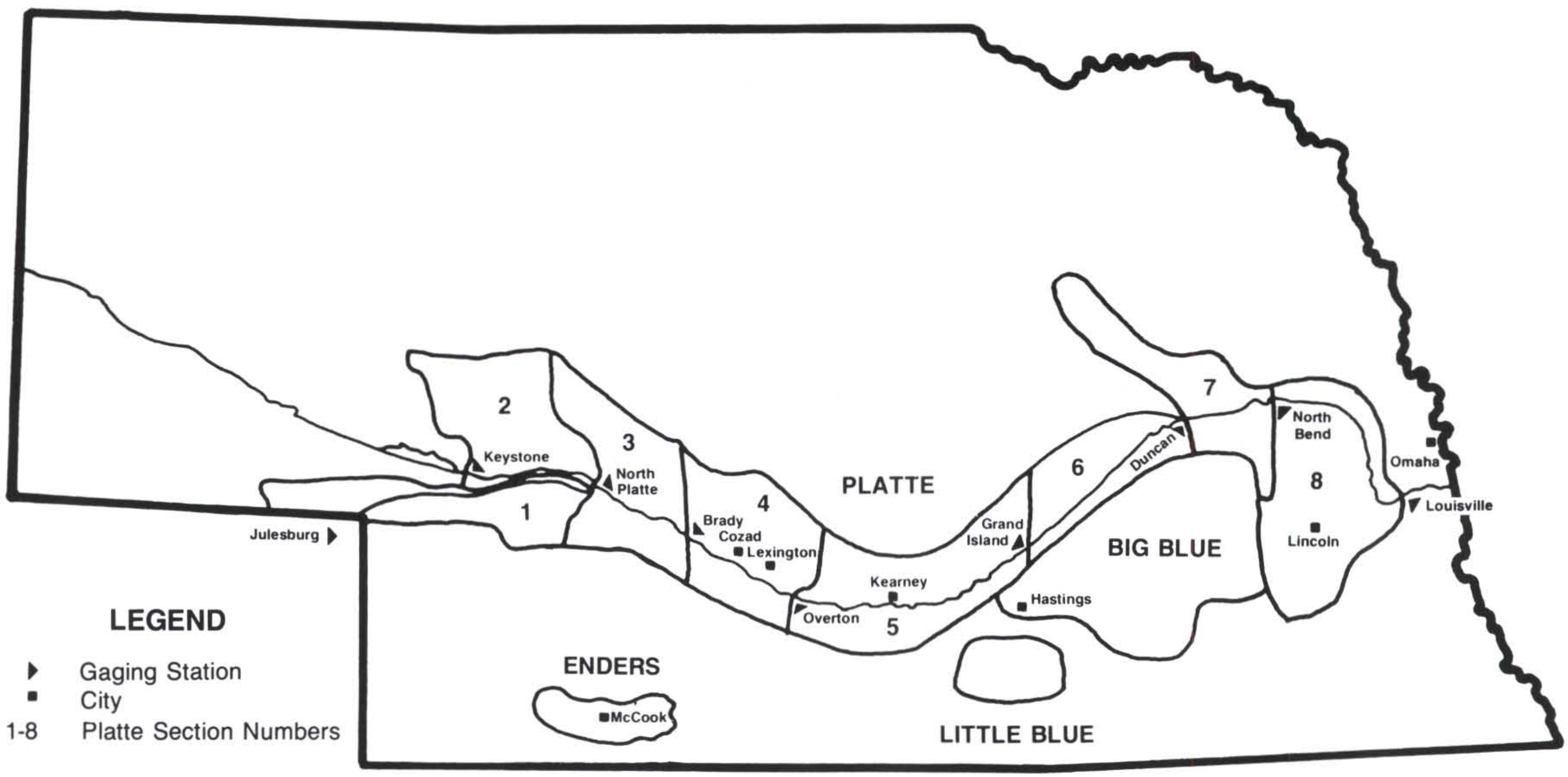


FIG. 1
Modeled Area

municipal/industrial, and economics. This division of work and responsibility allowed detailed discussion by small groups, minimum transfer of information between submodels, equal distribution of work among workshop facilitators, and efficient use of participants' abilities and backgrounds. The identified actions and indicators are listed with the description of each submodel in the following sections.

After the submodels were defined, workshop participants turned their attention to interactions among the submodels. Each submodel group described the information they needed from all other submodels. The result was a list of information flows or interactions that were needed to transform the sub-units into a whole system. The interactions essentially are links that tie the individual parts together. An illustration of the system showing submodels and interactions is displayed in Figure 2.

Submodels were constructed using available data, and existing models. It was necessary to make many simplifying assumptions and substitute less accurate and reliable data than desired in many cases because of the limitations of time and funds, and the need to use only methods and data understood and accepted by all participants. Everyone was informed of the assumptions and substitutions were kept in the open so the model did not become a mystery, understood only by programmers and technicians.

The following sections provide a general description of each submodel and its relation to the others. More detailed information is provided in the documentation of the model in the appendix to this report.

SURFACE WATER SUBMODEL

The function of the surface water submodel is to keep track of monthly flows, water supplies, and related characteristics in each section of the Platte River. It provides some of this data to other submodels as well as the modelers and workshop participants. Some of the types of information output for the participants is listed in Table 2 as indicators.

The surface water submodel operates on the basis of a water balance (gains and losses) in each of the eight sections of the river. It begins with gaged inflows at the upstream end of the model area (Julesburg and Keystone). Then monthly diversions for irrigation and storage are subtracted, exchanges with groundwater are calculated and tributary inflows are added. The result is the monthly inflow to the next section downstream. The routine is then repeated sequentially for the rest of the sections.

Use of historic data and the water balance approach for the surface water submodel required acceptance of a number of underlying assumptions. The basic assumption was that this method would adequately project future flows and produce reasonable projections of related conditions. Other assumptions were that:

(1) historic weather data would be representative of future weather, and consequently,

(2) historic streamflows, diversions, and groundwater/surface water exchanges would also be representative of future conditions;

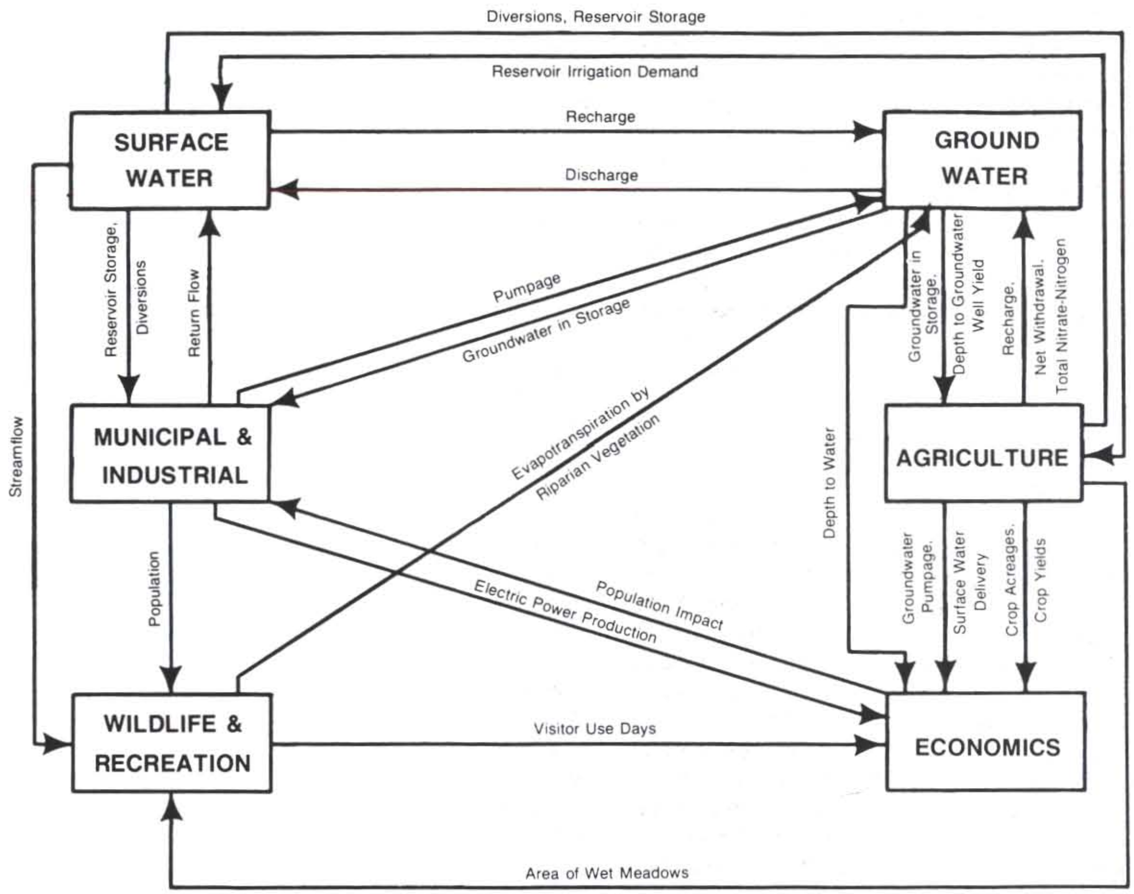
(3) no additional development will occur upstream;

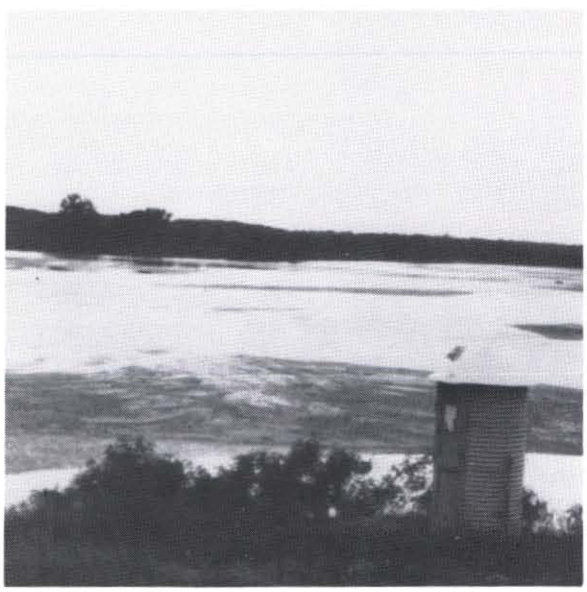
Table 2

SURFACE WATER SUBMODEL ACTIONS AND INDICATORS

Actions	Indicators
Alter interstate transfers	Instream flows
Alter interbasin transfers	Nitrate concentrations
Build storage reservoirs	Urban and agricultural withdrawals and returns
Alter management of stored water	Water available for meeting water rights
Alter withdrawal and return pattern	Acres flooded
Use water management to:	
1) stabilize existing uses	
2) expand irrigated acres	
3) maintain recharge rates	
4) maintain water quality (nitrates)	
5) maintain waterfowl habitat	

FIG. 2
Model Structure and Linkages





(4) ungaged groundwater/surface water exchanges calculated from historic streamflow records can be adjusted to adequately represent future conditions; and

(5) existing reservoirs will be operated in the future as they have been in the past.

The surface water submodel exchanges information with the other submodels in the system. It transfers to the wildlife/recreation submodel data on flows in the river, and no-flow days, on a monthly basis. The submodel calculates data concerning surface water quantity and quality (nitrate concentration) for the groundwater, agriculture and municipal/industrial submodels.

The surface water submodel also requires information from the other submodels. It requires data on the quantity and quality of groundwater/surface water exchanges from the groundwater submodel and return flow data from the municipal/industrial submodel. It also requires irrigation water demands from reservoirs from the agriculture submodel.

AGRICULTURE SUBMODEL

The agriculture submodel is responsible for calculating irrigation water demand for surface water and groundwater, groundwater pumped for irrigation, evapotranspiration from subirrigated lands, crop yields, crop acreages, land use (irrigated, dryland, pasture, etc.), and quantity of nitrate that enters groundwater from agricultural lands.

The calculations in the agriculture submodel for projecting crop yields, crop acreage, and land use are based on current (1980) conditions and projections made in the *Summary of the Nebraska Research for the Six-State High Plains Ogallala Aquifer Study,* (Nebraska Natural Resources Commission, 1981). For any year simulated, the crop yield, crop acreage and land use values are proportioned directly between the 1980 and 2020 values. The minimum well yield (in gallons per minute) is used in the agriculture submodel to calculate groundwater irrigated acres that convert to dryland due to reduction in the saturated thickness of the aquifer and consequent loss of well yield. A percentage of groundwater irrigated acres reverts to dryland when the well yield in a subunit declines to a certain value and the percentage increases as yields continue to decline.

Gross irrigation requirements, by crop, are estimated for a series of historic weather years using current irrigation practices and efficiencies. The corresponding deep percolation is also estimated for the same crops and years. These values together with crop acreages are used to calculate the irrigation demands for surface water and pumping of groundwater. The amount of nitrate that is leached into groundwater is calculated from average nitrogen losses for each crop for each inch of deep percolated water. Evapotranspiration from subirrigated lands is assumed to be equal to the irrigation requirement for alfalfa at initial groundwater levels. Calculated changes in evapotranspiration are directly proportional to changes in groundwater levels.

A major assumption made in the agriculture submodel is that historical weather patterns are representative of future conditions, so the corresponding estimated gross irrigation requirements are appropriate. Another assumption is that if an adequate supply of surface water is not available for irrigation the deficit will be pumped from groundwater.

The agriculture submodel is responsible for providing irrigation demands from reservoirs to the surface water submodel. It provides net withdrawal for irrigation,

Table 3

AGRICULTURE SUBMODEL ACTIONS AND INDICATORS

Actions	Indicators
Alter crop acreages	Demand for agricultural water withdrawals
Alter irrigation practices (type and acreages)	Crop yields
Change water utilization of crops	Crop and irrigation practice acreages
Change soil management practices **a/**	Livestock production **a/**
Limit irrigation withdrawals	Subirrigated acreages
	Water-use efficiency

a/ Identified at the workshop but not included in the model due to lack of time or information.

cropland nitrate losses to groundwater, and recharge to the groundwater submodel. The economics submodel relies on the agriculture submodel for crop acreages, crop yields, groundwater pumpage, and surface water use data. The agriculture submodel also calculates the area of wet meadows for the wildlife/recreation submodel.

To operate, the agriculture submodel requires well yield, depth to groundwater and water availability data from the groundwater submodel. It also requires surface water availability data from the surface water submodel.

MUNICIPAL/INDUSTRIAL SUBMODEL

This submodel simulates three general processes: (1) population growth; (2) withdrawal and returns of water for municipal/industrial and energy production purposes; and (3) electric power production. Within the submodel the monthly municipal/industrial demand for water is calculated by multiplying the population by an estimate of per capita water use. Current population and projected population growth rates are used to make new estimates of population each year. Monthly per capita use is estimated from average annual per capita use data and seasonal water use patterns. It is assumed that all municipal water is pumped from groundwater and all return flows to the river are a fraction of the amount pumped.

Projections of annual electric power production are based on projections by the power districts and separate projections for municipal power plants. The portion generated at hydroelectric plants is based on relationships with historical production and diversions.

Monthly production is calculated by multiplying annual production totals by a monthly distribution pattern. It is assumed that only thermal electric power plants with cooling towers consume significant quantities of water. Monthly consumptive use of water is calculated using an average consumption rate for plants with cooling towers, 600 gallons per megawatt-hour, and the projected monthly production.

The submodel uses reservoir storage and diversion data from the surface water submodel to calculate hydroelectric power production. It uses data on the

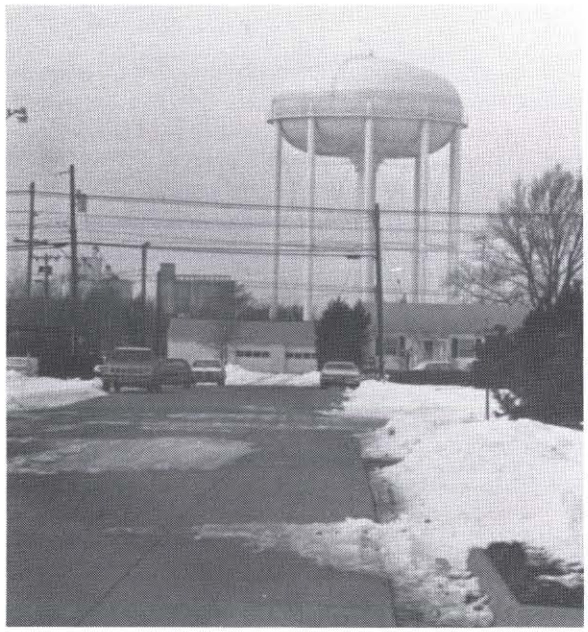


Table 4

MUNICIPAL/INDUSTRIAL SUBMODEL ACTIONS AND INDICATORS

Actions	Indicators
Alter municipal/industrial water withdrawals	Municipal/industrial water requirements
Alter electric power water withdrawals	Electric power water requirements
	Electric power production
	Human population
	Flood damage **a/**

a/ Identified at the workshop but not included in the model due to lack of time or information.

amount of groundwater in storage from the groundwater submodel to evaluate the availability of water for municipal use. It also uses data from the economics submodel for estimating future population. The municipal submodel supplies groundwater use, surface water returns, population and electric power production data to other submodels.

WILDLIFE/RECREATION SUBMODEL

The general purposes of the wildlife/recreation submodel are to estimate and report: (1) the amount of open channel and riparian vegetation, and the amount of evapotranspiration from that vegetation; (2) the relative value of habitat, based on estimated values at median flows, for Sandhill cranes, channel catfish, and a forage fish; (3) the projected proportion of target flows for bald eagles and whooping cranes specified in the "Biological Opinion, Little Blue Natural Resources District — Catherland Project," (Biological Opinion) that will be flowing in the river in the future; and (4) the number of recreation use-days for hunting, fishing, and boating.

The riparian vegetation includes wet meadows, shrubs and trees. The estimates of the changes (from 1980 conditions) in the number of acres of open

Table 5

WILDLIFE/RECREATION SUBMODEL ACTIONS AND INDICATORS

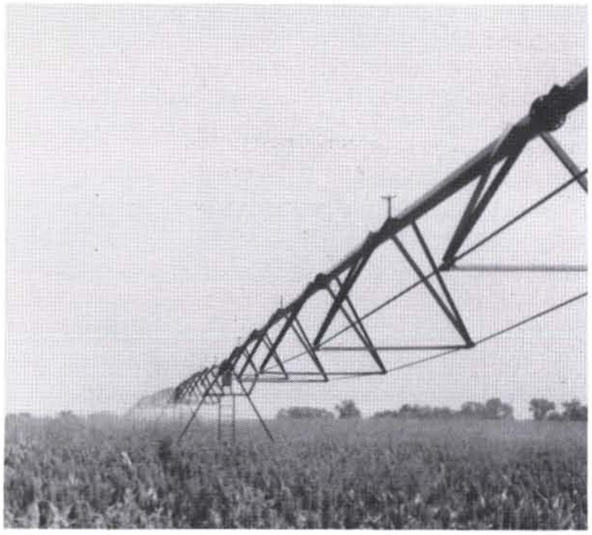
Actions	Indicators
Clear woody riparian vegetation Alter channel width	Acreages of four riparian habitat types **a/** Relative amount of crane habitat **b/** Relative amount of least tern nesting habitat **a/** Relative amount of duck migration hunting habitat **a/** Relative amount of overwintering, spawning, and production habitat for channel catfish and a representative forage fish **b/** Relative amount of habitat for a generalized forest mammal **a/** Recreation user-days for hunting and fishing

a/ Identified at the workshop but not included in the model due to lack of time or information.
b/ Relative is defined as a proportion of the amount present in 1982.

channel versus vegetated sandbars are based on a ratio of projected streamflows to an historic average flow.

Available data did not allow calculation of direct values of habitat, so relative values were used as indicators. The Instream Flow Incremental Method was employed to estimate target habitat values and values at projected streamflows. Relative habitat indicators were based on the comparison of current values and projected values.

In addition to calculating the indicators listed above, the wildlife/recreation submodel provides evapotranspiration data to the groundwater submodel and the rate of recreation use to the economics submodel. To operate, the submodel requires flow data from the surface water submodel, acres of subirrigated crops from the agriculture submodel and human population data from the municipal/industrial submodel.



GROUNDWATER SUBMODEL

The primary functions of the groundwater submodel are to estimate the quantity of groundwater in storage, groundwater/surface water interchange and groundwater quality. The submodel also calculates water table elevation and depth to groundwater.

Computation of the quantity of groundwater in storage is based on net withdrawals of groundwater for activities in other submodels. The storage calculations are in turn used to estimate changes in water table elevations. Groundwater/surface water exchanges are computed using deviations of groundwater in storage relative to initial conditions. Groundwater quality (nitrate concentration) conditions are calculated as a function of nitrate losses from agricultural lands, nitrate contained in water pumped for irrigation, and the dilution effects of groundwater/surface water interchanges.

The groundwater submodel requires pumpage data from the municipal submodel and riparian evapotranspiration data from the wildlife/recreation submodel. It requires net withdrawal, recharge, and total nitrate-nitrogen from the agricultural submodel. The submodel provides groundwater in storage, depth to water and well yield information to the agriculture submodel, depth to water data to the economics submodel, and groundwater/surface water exchange data to the surface water submodel.

Table 6

GROUNDWATER SUBMODEL ACTIONS AND INDICATORS

Actions	Indicators
Alter groundwater augmentation 1) injection **a/** 2) irrigation seepage 3) storage seepage Integrate surface and groundwater management	Groundwater levels Urban and agricultural withdrawals and recharge Nitrate concentrations Well yields Groundwater exchanges with Platte River

a/ Identified at the workshop but not included in the model due to lack of time or information.

ECONOMICS SUBMODEL

The primary purpose of the economics submodel is to generate data on economic benefits from agricultural crop production, recreation and electric power production. The submodel also produces employment changes in the agricultural sector and indirect output changes.

Net returns for agricultural crop production activities are calculated using estimated irrigation pumping costs and surface water charges with projected crop prices, crop yields, and production costs from the High Plains Study. Recreation benefits are calculated for reservoir activities using population density data and a monetary value of a user-day. Other user-days (from the wildlife/recreation submodel) are multiplied by the same value. Electric power generation benefits are calculated using the difference in the cost of production between thermal and hydro generation facilities.

Indirect impacts from agricultural and recreation activity are evaluated in the model by applying a multiplier to the direct returns generated in these sectors. Changes in employment in the agricultural sector are calculated from changes in gross returns in agricultural production.

An important assumption in the economics submodel is that state-level output and employment multipliers are representative of the region, that is, the region has a homogeneous economic base. The most significant limitation of the model is the lack of detailed information on capital costs and operation and maintenance costs for proposed projects.

The economics submodel provides data on population changes resulting from economic impacts to the municipal/industrial submodel. It relies on the agriculture submodel for water use, crop acreage and crop yield information. The submodel also receives information on electric power generation from the municipal/industrial submodel, recreation user-days from the wildlife/recreation submodel, and depth to the water table from the groundwater submodel.

MODEL COMPOSITION AND OPERATION

The Platte River Forum model is more than the sum of its parts, or submodels, that have been summarized above. When linked together, the submodels interact to form the model that can produce much more than the outputs of the submodels added together. Each submodel by itself is meaningless because it requires information from other submodels. Each was tailored with the requirements of the other submodels and the broader scope of the whole model in mind. Most submodels were built using data and results from other models that in most cases were based on years of research and tempered with the judgement of experienced, knowledgeable people. The result is a model that contains complex, interactive parts that are separated to make them easier to understand.

Table 7

ECONOMICS SUBMODEL ACTIONS AND INDICATORS

Actions	Indicators
Alter crop prices	Economic costs and benefits of water management alternatives
Alter demand for agricultural products **a/**	Net returns to agriculture, recreation, electic power generation
Alter availability of state/federal funds **a/**	Level of industrial activity **a/**
	Employment and income by economic sector **b/**

a/ Identified at the workshop but not included in the model due to lack of time or information.
b/ Employment and income are included in the model only for the agricultural sector.

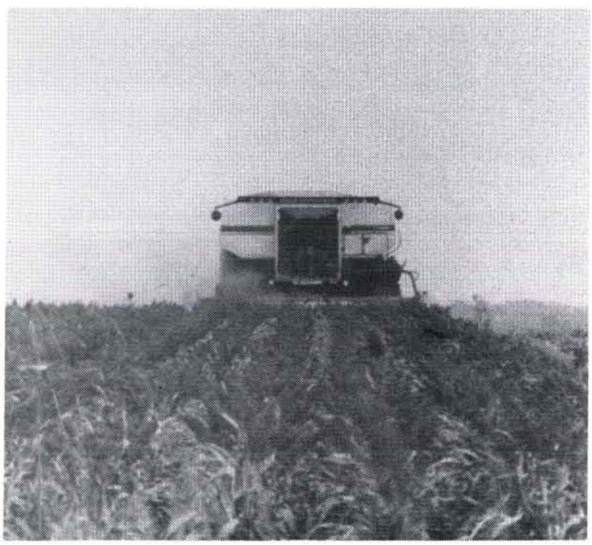
Chapter 3
OUTPUT OF THE MODEL

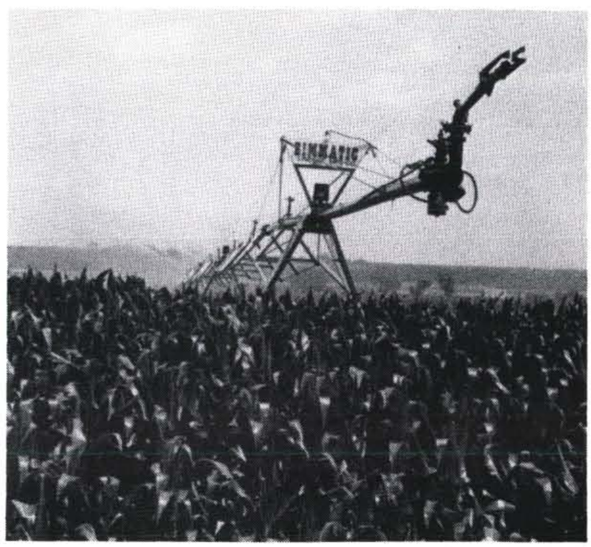
The Platte River Forum model was programmed to output the values of hundreds of variables, including the indicators (measures of performance) identified in meetings and workshops. These outputs range from direct measurements such as streamflow in cubic feet per second to indirect effects like population in the model area. The major indicators are listed in the sections describing each submodel in Chapter 2. The model can also produce values for a vast number of other variables that are used to check the operation of the model and supplement the information provided by the indicators. All results can be displayed in the form of tables or graphs.

The model has not yet been used to its fullest capacity. It has been used only to produce information on the performance of a limited number of alternatives within several scenarios. The first is the baseline, which serves as the basis for comparing the performance of management alternatives in the other two scenarios. Since the outputs of these scenarios were displayed for workshop participants and policy makers, the model has been improved so it is capable of outputting the results of more scenarios with different management alternatives.

Before using the model or its outputs, it is necessary to understand their intended purposes and the capability of the model. The model was intended, and programmed, to provide results that show the magnitude and direction of the outputs, not precise values. The results should be used to discern trends, or to determine whether the effect is positive or negative, not to predict whether one project produces 100 acres, or even 1,000 acres, more irrigated land. The model was built to produce general answers because: (1) the methods and relationships had to be straightforward and understandable to everyone; (2) some of the data were not very detailed or precise, even though they were the best available; and (3) long-range projections of future actions seldom prove to be accurate, but the comparisons of one alternative to another can be reasonably precise. For example, it is more difficult to determine whether one proposal might be profitable than it is to show that one of five similar proposals might earn more than others.

Only the output of the baseline scenario gives definitive values of outputs such as the rate of increase in irrigated acres. Even so, these figures should only be used to judge whether the rate is increasing half, or twice, as fast as in previous years, or whether it will peak and decline as groundwater irrigated acres begin to revert to dryland. The output of the management scenarios should only be used to compare them with the baseline or one another, or to determine trends within the scenario. For instance, irrigation project outputs should only be used to determine whether the total irrigated area will increase over the baseline, or whether it will remain constant as groundwater irrigated acres are converted to surface water.





Baseline Scenario

The purpose of the Baseline Scenario is to provide a basis for comparison of alternatives. It gives an indication of what future conditions might be like if present trends continue, without additional controls or proposed projects. It identifies which future conditions will be different from historical conditions to provide a better basis for comparison of various management scenarios.

BASELINE ASSUMPTIONS

Certain assumptions must be made before Baseline projections can be made. The major assumptions are that: (1) historical data can be used to represent future activities of existing systems, unless specific changes are made, (2) historical weather patterns and conditions dependent on weather could recur in the future, and (3) it is reasonable to project historical trends into the future.

An example of the first assumption is historical water use data. It was assumed that nearly all historical water rights will still need to be met in the future before any new demands can be supplied. The most significant example of the second assumption built into the model is that the historical weather pattern is a series of random occurrences that could reasonably be expected to occur again, so historical streamflow records can be repeated to simulate future conditions. Extrapolating the growth rate of irrigation development into the future is an example of the use of historical trends to project future development.

BASELINE OUTPUTS

Thousands of outputs can be displayed when thorough understanding of the model is needed, but for this report only one or two from each submodel will be shown. Since much of the controversy stems from demands on the river between Overton and Grand Island, the examples will focus on this area.

The projected flow at Grand Island produced by the surface water submodel is shown in Figure 3. The historical flow records of 1959-1978 have been adjusted to account for additional groundwater development to produce this graph. The most significant features are the high and low flow periods which reflect the variability in historic weather patterns.

The projected number of no-flow days in a year is based on a statistical correlation of historical daily flow data relating the number of no-flow days per month to

FIG. 3

Baseline Projection of Annual Flow in the Platte River at Grand Island

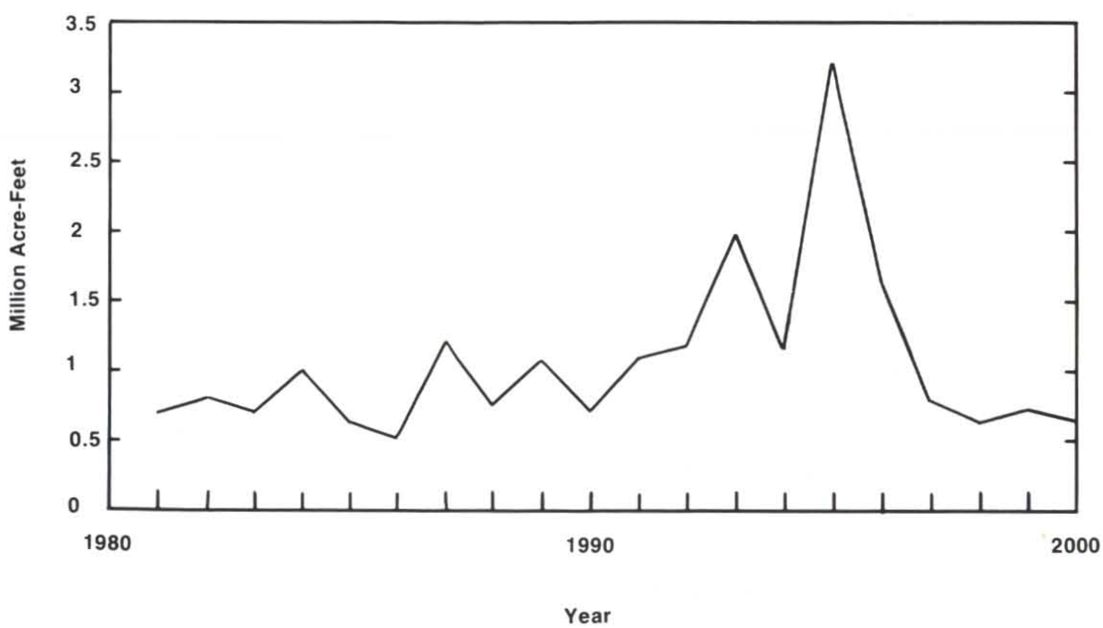
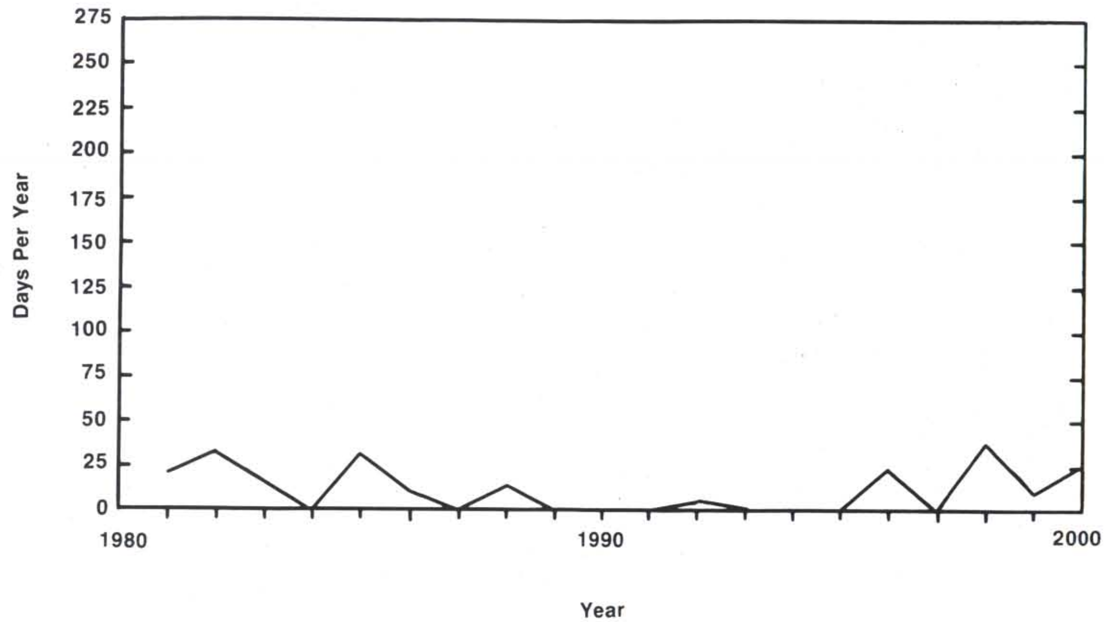


FIG. 4

Baseline Projection of Annual No-Flow Days in the Platte River at Grand Island



the average flow for each month. Examination of Figure 4 indicates that only 8 of the 20 years would have zero no-flow days and several would have more than 25 no-flow days. The average for all years would be over 10 no-flow days per year.

An example of the future growth of irrigated acres is shown in Figure 5 for the area north of the river between Overton and Grand Island. The projected number of irrigated acres would increase steadily throughout most of the period. In later years, as the water table in the aquifer declines and irrigated acres begin to revert back to dryland, the increase in the total number of irrigated acres would be smaller.

FIG. 5 Baseline Projection of Irrigated Acres (North of the Platte River Between Overton and Grand Island)

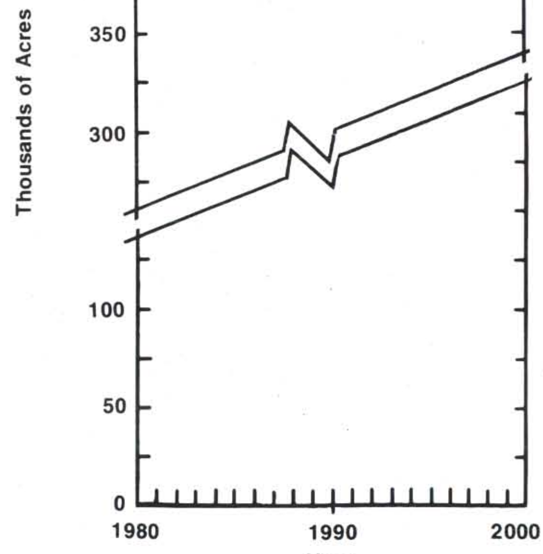
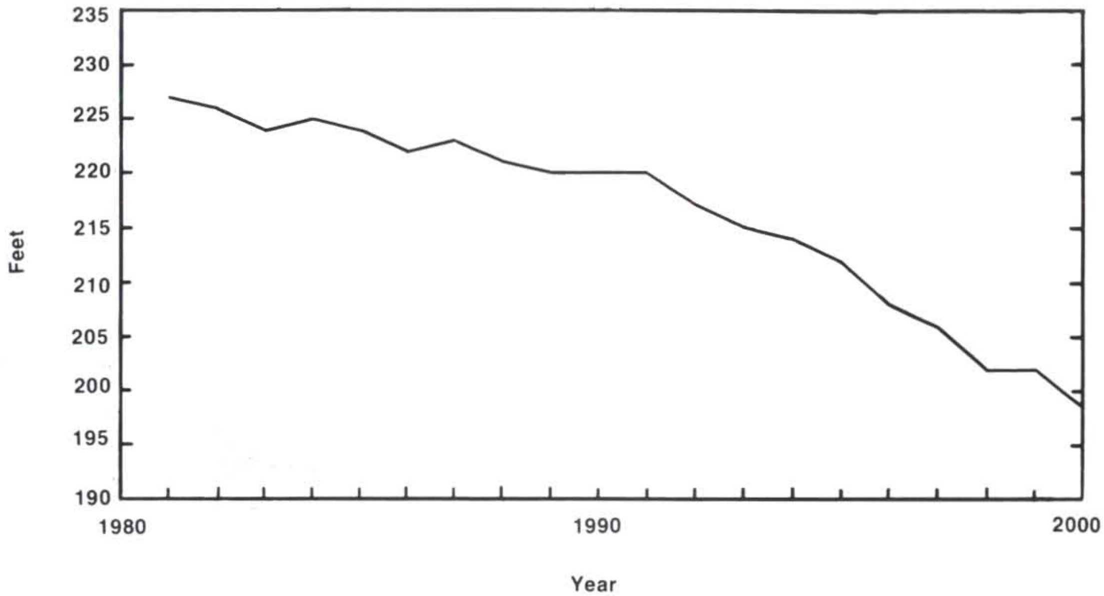


FIG. 6

Baseline Projection of Average Aquifer Saturated Thickness
(North of the Platte River Between Overton and Grand Island)



The projected average thickness of the aquifer in this same area in future years is shown in Figure 6. While the general downward trend can be related to the additional irrigated acres, the periods of sharp declines can be related to the dry periods in the historical weather pattern.

Whooping crane habitat is important in the section between Overton and Grand Island because it is part of the area designated critical habitat for the cranes. The depth and velocity of flow in the channel are two important habitat requirements. Indicators of the future availability of these types of habitat in the spring and fall are shown in Figure 7. It shows the ratio of projected flows in the river to flows specified by the Game and Parks Commission in the Biological Opinion. The specified flows are believed to be necessary to provide the amount of these two types of habitat required to maintain the species.

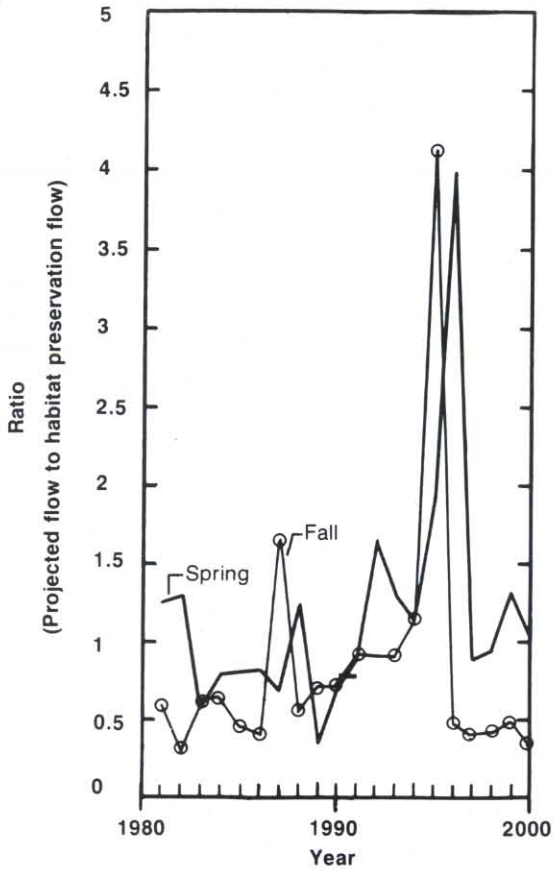
The spring indicator line shows an equal number of years above and below 1.0 (100 percent of specified flows), scattered throughout the study period. This indicates that no trend in change of spring habitat can be discerned yet. The fall indicator line is similar to the spring line, but lower. The average value for spring would be slightly above 1.0, but the fall average would be only about 80 percent of the specified value. Both habitat values will take on more significance in the next section when compared to management scenario results.

Management Scenarios

The Platte River Forum model is currently capable of calculating the results of management actions, including development projects, in combinations termed scenarios. The management actions fall into three categories: (1) development of irrigation projects, (2) provision of instream flow, or (3) construction of regulating reservoirs. Irrigation projects can have diversion canals, reservoirs, distribution canals, and irrigated land which can be converted from groundwater irrigated land, dryland, or both. Instream flows can be provided by regulatory action such as requiring that flows be bypassed or by construction of reservoirs and release of water from storage. Regulating reservoirs are not part of any specific irrigation project. They can be used to capture excess flows for release as needed for irrigation or instream flow.

FIG. 7

Baseline Projections of Relative Whooping Crane Roosting Habitat Indicator



MANAGEMENT SCENARIO DESCRIPTIONS

The results of two management scenarios have been presented to the public. These two were selected to illustrate what the model could do and what could be done with the results. To best demonstrate the capabilities of the model and provide a view of two extremes for further discussion, the actions combined in these scenarios were selected to fulfill the widest potential range of objectives. These objectives were to: (1) protect instream flows to provide designated wildlife and recreation benefits while allowing some economic development, or (2) develop as much irrigation as possible within the existing framework of water rights. The two types of management actions selected to accomplish these objectives were legal protection of instream flows and development of surface water irrigation projects.

At the time there were no legal protections for instream flows, so it was assumed that some legislation would be enacted to guarantee that needed flows would not be diverted. Surface water irrigation projects can

be developed within the existing legal structure. The first step in the legal procedure, applying for a water right, has already been taken for a number of projects. Three of these were selected for their impacts on the critical reach of the river and the number of acres they would irrigate with surface water.

The three projects selected were the Prairie Bend Unit, the Catherland project, and the Landmark project. The Prairie Bend Unit was a consolidation of the water rights applications of two reclamation districts in the Central Platte area. That was the way the feasibility study was being conducted at that time.

The Prairie Bend Unit was the only inbasin project. It would divert water from the Platte River upstream from the Overton gage to storage reservoirs north of the river in the section between Overton and Grand Island. This water would be used for irrigation and recharging the groundwater in that section of the Platte River Basin.

The Catherland project would transfer water from the Platte River Basin to the Little Blue River Basin. It would divert water that normally is returned to the Platte River just upstream from the Overton gage. The water would actually be diverted through the existing canal of another irrigation project during the off season. A new canal crossing the basin divide would carry it to a reservoir on the Little Blue River. The water would be used to irrigate lands in the upper part of that basin which currently have no source of supply.

The Landmark project would transfer water to the Big Blue River Basin. The water would be diverted by pumping from the section below Grand Island. It would be stored in several reservoirs in the upper part of the Big Blue. It would be used to irrigate lands and recharge the groundwater in areas currently experiencing extensive water table declines.

Different combinations of these actions were used in the management scenarios. The more important input data needed for modeling them is given in Table 8.

The first scenario might be named the Instream Flow Scenario. The features were selected to provide the needed benefits from instream flow and still produce greater economic benefits from irrigation. First priority (after satisfying existing water rights) was given to protection of instream flows in the reach from Overton to Grand Island. The flows were those specified by the Game and Parks Commission in the Biological Opinion, except that scouring flows were not provided.

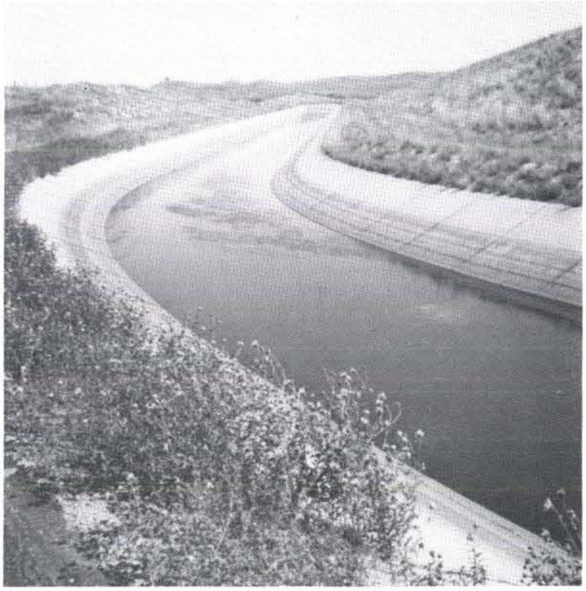
A report by hydrologists from a federal agency indicates that very high flows would be required to scour vegetation from the sandbars and islands in the river. On the basis of that report the Biological Opinion says that 3,800 cubic feet per second for 23 days per year would be needed to be sure that a 500 foot wide channel free of woody vegetation could be maintained by scouring. There are some indications that this much flow is no longer available for that many days. Since it could not be provided during the simulation period, no useful purpose would have been served by analyzing it. Therefore, scouring flows were not included in any scenario.

In the Instream Flow Scenario, diversions for irrigation were allowed if they did not affect instream flows. Second priority was given to the Landmark project, planned by the Upper Big Blue NRD, because it is downstream from the critical habitat area. Third priori-

Table 8
MODEL INPUT DATA FOR MANAGEMENT SCENARIOS

Item	Units	Prairie Bend Unit 4/	Landmark	Catherland	Instream Flows 5/
Section 1/	No.	4	6	4	5
Water Requirement	(acre-feet)	387,100	300,000	125,000	609,000
Storage	(acre-feet)	578,750	300,000	122,000	0
Reservoir Surface Area	(acres)	23,173	30,000	4,400	0
Section Irrigated	No.	5	11	10	—
Irrigated Lands 2/	(acres)	125,000	80,000	66,500	0
Converted Lands 3/	(acres)	107,150	68,600	0	0
Capital Investment	($1,000,000)	209.2	500.0	118.3	0.0

1/ Location of diversion or critical need for water; see Figure 1 for location
2/ Total irrigated lands including corn, soybean, grain sorghum, wheat, and alfalfa
3/ Groundwater irrigated lands converted to surface water irrigation
4/ Combination of Prairie Bend Project and Twin Valley Project
5/ Flows specified by the Game & Parks Commission in the first biological opinion (minus scouring flows)



ty was given to another interbasin transfer, the Catherland project proposed by the Little Blue NRD.

The second scenario could be called the Diversion Scenario, because priorities were given to irrigation projects that divert water out of the river below Lexington. Priorities were arranged in order of application: Prairie Bend Unit first, Catherland project second, and Landmark project third.

MANAGEMENT SCENARIO ASSUMPTIONS

Just as in the Baseline, several assumptions were made in the management scenarios. The most important was that all demands must be served in order of priority and the project with the highest priority had to be provided its entire demand first. Also, it was assumed that new demands could not interfere with historical withdrawals. Another major assumption was that all surface water reservoirs with unused capacity had to be refilled as soon as possible, given the constraints of priority, supply, and canal capacity. Another was that all seepage from project lands (which included a nitrate loading) would recharge the groundwater reservoir.

MANAGEMENT SCENARIO OUTPUTS

The outputs of the scenarios can be displayed on a computer screen or on paper, in the form of graphs and tables. In the following selected examples, the management scenario outputs are compared to the baseline results.

The projected annual flows in the Platte River at Grand Island are shown in Figure 8. It can be seen that the Instream Flow Scenario does not produce deviations from the baseline as large as those caused by the second scenario. There are several reasons for this:

FIG. 8

Projected Annual Flows in the Platte River at Grand Island for Three Scenarios

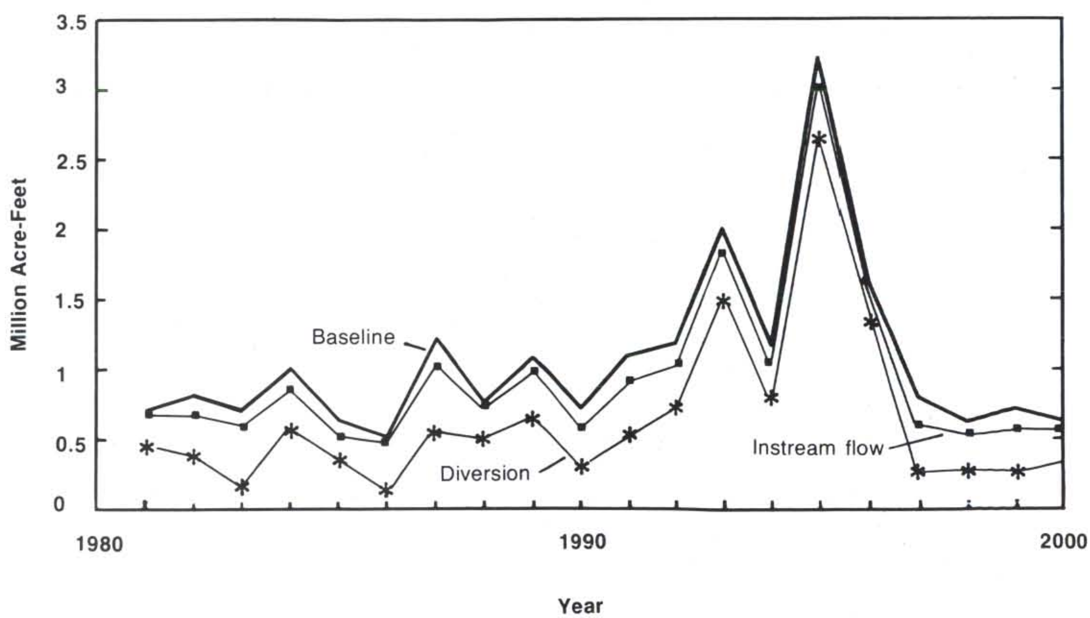


FIG. 9

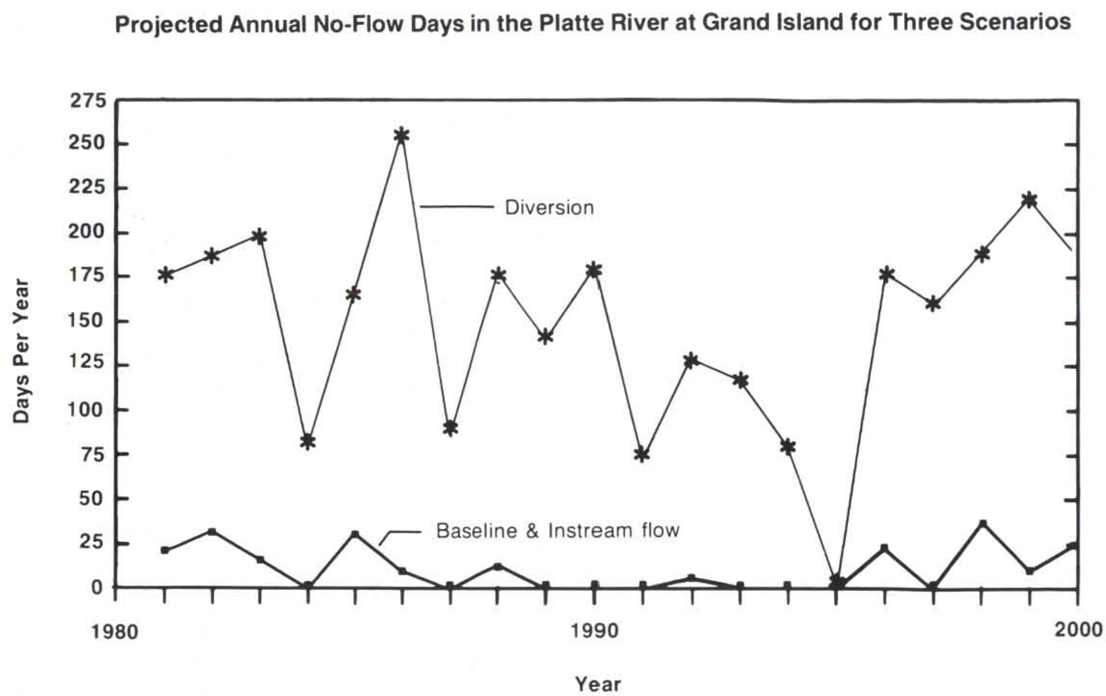
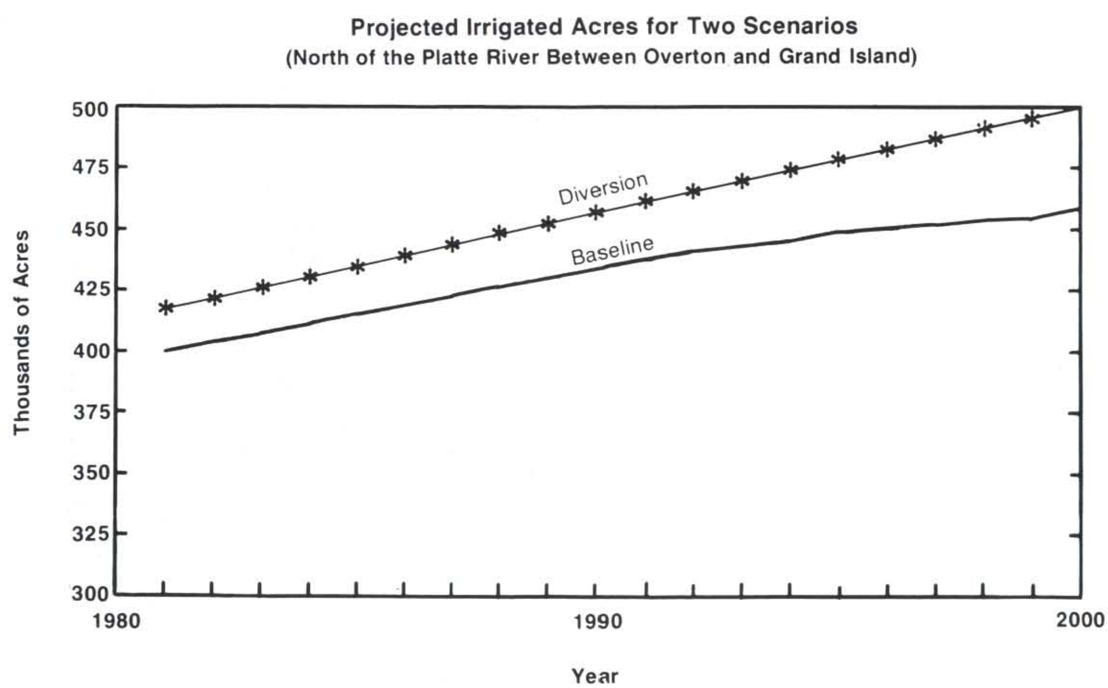

Projected Annual No-Flow Days in the Platte River at Grand Island for Three Scenarios
Days Per Year
275
250
225
200
175
150
125
100
75
50
25
0
1980
1990
2000
Year
Diversion
Baseline & Instream flow

FIG. 10


Projected Irrigated Acres for Two Scenarios
(North of the Platte River Between Overton and Grand Island)
Thousands of Acres
500
475
450
425
400
375
350
325
300
1980
1990
2000
Year
Diversion
Baseline

(1) first priority in the Instream Flow Scenario is to protect the flow at Grand Island as much as possible,

(2) the diversion point for the second priority in that scenario is located downstream of Grand Island, while the diversions for the first and second priorities of the Diversion Scenario are located upstream of Grand Island, and

(3) there is relatively little water available for diversion to the third priority (the Catherland project) in the Instream Flow Scenario, so diversions above Grand Island are small.

Projections of the number of no-flow days are shown in Figure 9. The Instream Flow Scenario is identical to the Baseline. However, the no-flow days under the Diversion Scenario increase dramatically. Monthly data on the number of no-flow days shows that the river would be dry for most of the irrigation season and immediately afterward, but there would be very few no-flow days during the winter and spring months. This happened because the algorithm for irrigation projects called for diversions whenever there was unused reservoir capacity. By delaying the diversions until the spring months, the number of no-flow days could have been reduced significantly.

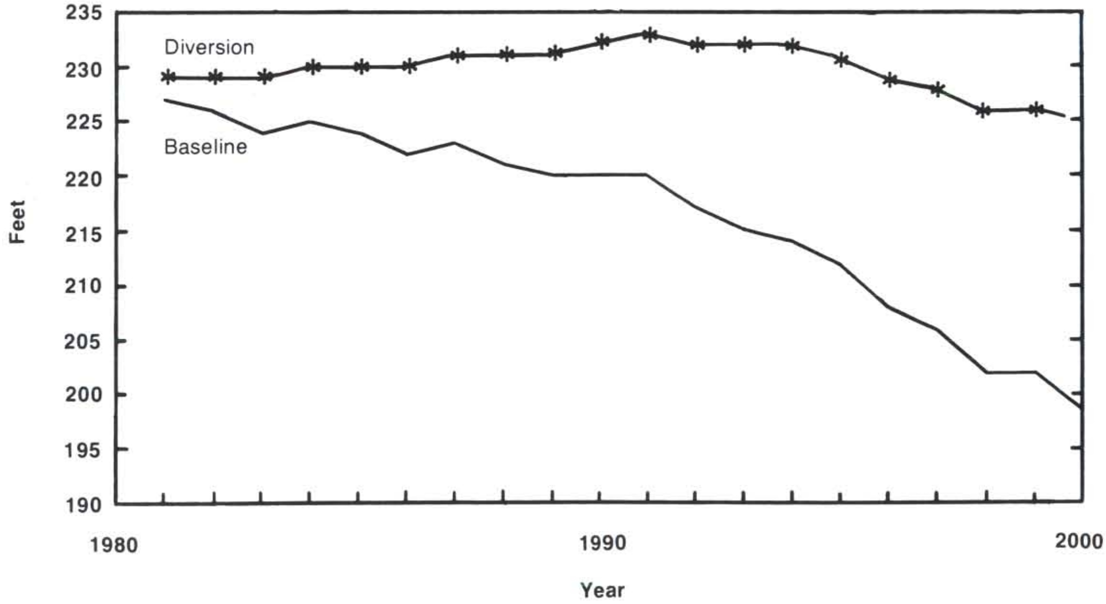
In the Instream Flow Scenario the number of irrigated acres on the north side of the Platte River between Overton and Grand Island would be the same as in the Baseline, so results from that scenario are not shown on Figure 10. The Prairie Bend Unit would be the only project located in this section, and it was included only in the Diversion Scenario. The most significant feature of this graph is that the Baseline growth rate decreases as the groundwater acres revert back to dryland, but the rate in the Diversion Scenario does not change. This would occur because the project would convert about 100,000 acres of land currently irrigated with groundwater to surface water irrigation. This not only would recharge the groundwater with surface water, it also would reduce groundwater pumpage significantly. The initial difference between the Baseline and Diverion scenario in 1981 would be due to the conversion of about 18,000 acres from dryland to surface water irrigation.

Projections of the average saturated thickness of the aquifer north of the Platte River from Overton to Grand Island are shown in Figure 11. It also shows only the Baseline and Diversion Scenarios. For most of the simulation period, the saturated thickness would increase and the water table would rise in the Diversion Scenario, as a result of less pumping and more recharge. Water table declines would resume in the last few years. At that time, pumpage would again exceed recharge from surface water irrigation seepage, because of continued groundwater irrigation development and continued pumping on acres that would not revert to dryland.

FIG. 11

Projected Average Saturated Thickness of Aquifer for Two Scenarios

(North of the Platte River Between Overton and Grand Island)



Another way to demonstrate the shortcomings of the part of the model that controlled diversions is to examine the projections of the streamflow habitat indicator for whooping crane habitat in the spring and fall. Figures 12 and 13 show flow ratios for the management scenarios compared to the Baseline shown in Figure 7. With most of the diversion taking place in the fall, the relative habitat value would be decimated under the Diversion Scenario. The spring habitat values, although degraded, would still be present.

FIG. 12 Projections of Spring Whooping Crane Roosting Habitat Indicator for Three Scenarios

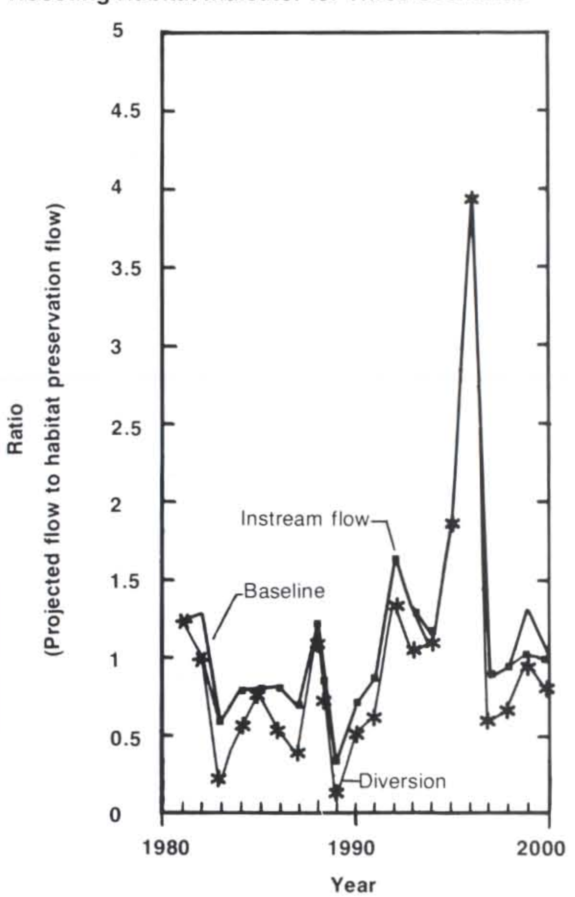


FIG. 13 Projections of Fall Whooping Crane Roosting Habitat Indicator for Three Scenarios

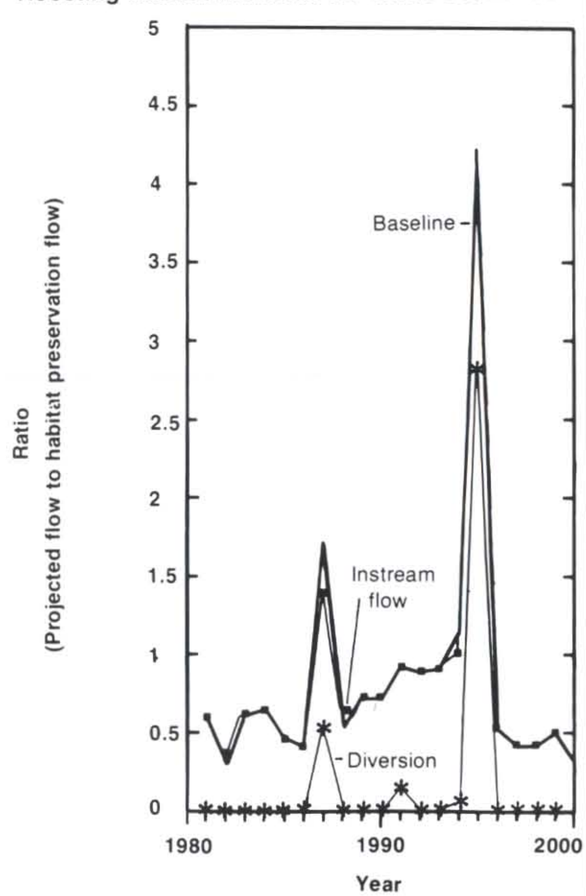
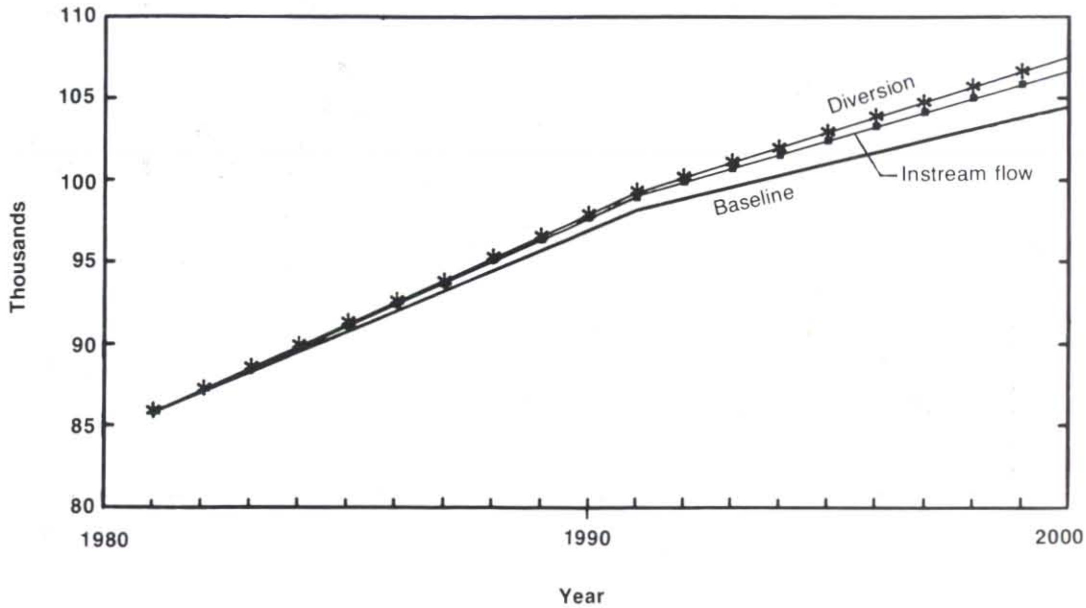


FIG. 14

Projected Population in the Platte River Valley from Overton to Grand Island for Three Scenarios



In the model, changes in population in a section are related to additional surface water projects located anywhere in the modeled area. Consequently, Figure 14 shows an increase in population for the Overton-Grand Island section for the Instream Flow Scenario even though no projects would be located there. The growth shown in the Diversion Scenario is a little higher because it would include more irrigated acres.

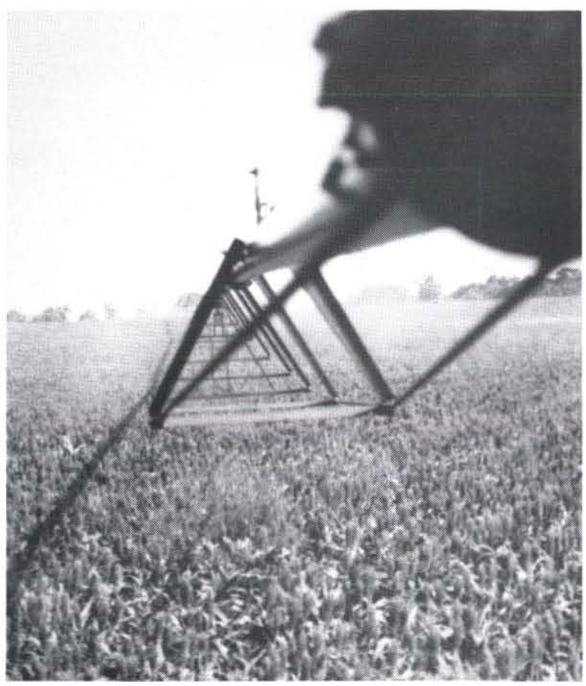
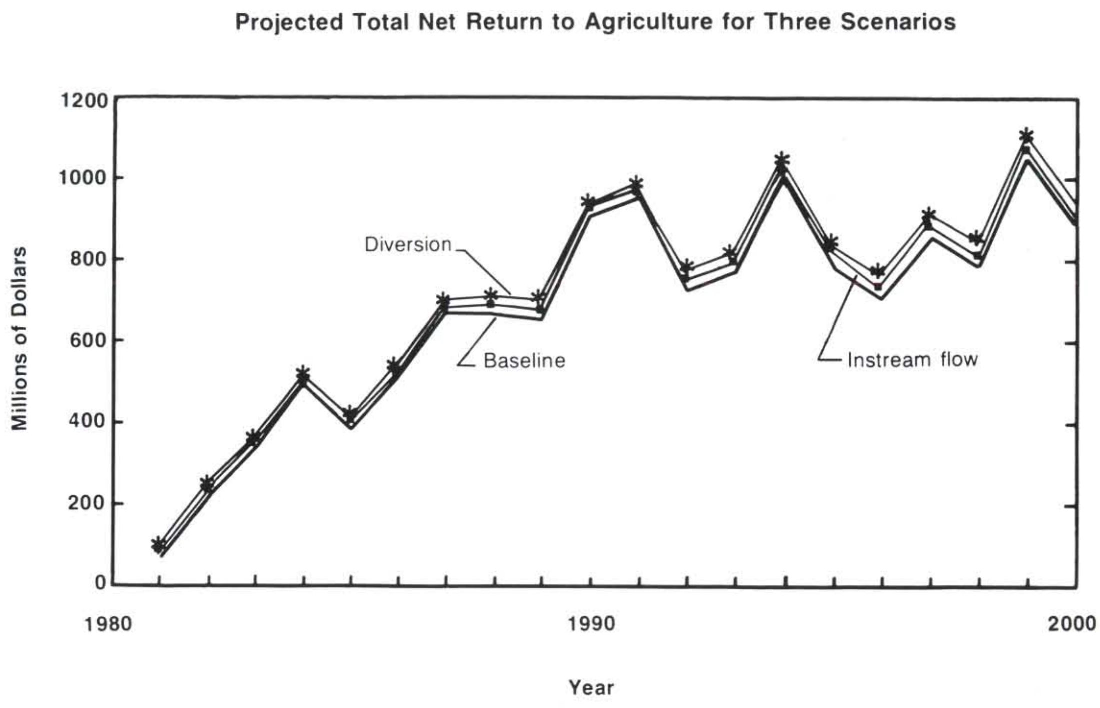


FIG. 15



One indicator of the economic impact of the management scenarios is the net return to land and management. The total net returns for the entire modeled area were used as the basis for comparison in Figure 15 because the projects in the two management scenarios would be located in different sections. Net returns to land and management (the amount of farm income left after all costs except land and management charges are paid) have been used because it is impossible to develop direct estimates of farm income effects.

The timing of construction of the projects would have a significant impact on the benefits shown in Figure 15. In these scenarios, the projects would be constructed immediately, so most of the project acres would already be irrigated with groundwater. There would be little change in agricultural income. If construction were delayed, more of the project acres would have reverted from groundwater irrigation to dryland and the impact on agricultural income would be greater.

The preceding are only two examples of the scenarios that are possible. They reflect the approximate extremes of a wide range of possibilities. The Instream Flow Scenario emphasized protection of riparian wildlife habitat, particularly habitat for cranes, eagles, least terns and fish. The objective of the Diversion Scenario was to use river water to irrigate as many acres as possible. The projected values for these examples show how complex even the simplest indicator can become. Many more variables would have to be examined in order to fully understand the model and other scenarios would have to be evaluated to make informed decisions.

Chapter 4
CURRENT STATUS, NEEDS AND POTENTIAL USES

A stated objective of the Platte River Forum for the Future was to provide a means of resolving conflicts among users or potential users of Platte River water. Although the Forum process has not yet resolved any conflicts, significant progress was made and more can be accomplished. The Forum focused attention on the wisdom of seeking a solution through negotiation backed with knowledge of the potential impacts of proposed actions. It also led to the recognition that the most appropriate uses for the remaining unallocated flow may involve combinations of proposed projects, parts of different projects, or future uses not yet proposed.

Current Status

Most of the activities in the Platte River Forum process have been suspended indefinitely. The only exception is the development of the model by the core team. The model is currently being refined and expanded for future use. The meetings and workshops conducted during the Forum produced a cooperative attitude and the willingness to try to define the relationships that would enable the model to represent the Platte system satisfactorily. The result was agreement on modeling techniques and operational details that provided the basis for a model that can be maintained and refined for use in future studies and reviews.

Some of the types of results the model was capable of producing in November 1983 are shown in the preceding chapter. At that time, the number of alternatives that had been evaluated was very limited. Since then, the full range of alternatives it was designed to examine have been explored, and the model has been refined and expanded. It has been given additional flexibility, including the ability to analyze the projects in different orders of priority. The ability to examine some potential storage projects has also been added.

Refinement of the model will continue in the future. Models being developed for other studies and other modeling techniques are being reviewed for possible adaptation to the Forum model.

Potential Capabilities and Uses

The Forum process can be used to improve the understanding of the Platte River system, provide a setting for negotiations, and produce the basis for informed decisions. The potential results that can be achieved through this process depend on the purposes and goals established for it, the degree of commitment to it by competing interests, and the willingness of decision-makers to use the information produced.

CURRENT CAPABILITIES OF THE MODEL

The full potential of the model can best be realized through the Forum process, but it can also be used beneficially in other ways. The information the model can produce is pertinent to the required decisions regardless of the process used.

The chapter on model output demonstrated some of the capabilities for quantifying the chosen indicators of performance. It also gave examples of some of the actions (management alternatives) that can be explored with the model. Most of those actions were structural alternatives, primarily irrigation projects, but it also included the option of maintaining wildlife habitat by giving the highest priority to the flows specified in the Biological Opinion.

The model is capable of analyzing alternatives that have not yet been analyzed in the Forum. The two management scenarios previously analyzed were fairly limited in scope, and they were constrained to illustrate two extreme positions. The model could currently be used to examine a wider range of management actions intended to fulfill more diverse objectives.

Much of the controversy concerning use of the river centers on diverting water out of the channel versus maintaining flows in the stream. Consequently, only the capabilities of the model that address that issue have received much attention, but it can simulate the effects of numerous other alternatives. Many of them, although not related directly to the issue of diversion versus instream use, may have an effect that could contribute to the resolution of that conflict. An example of such an alternative is an effecive reduction in the amount of groundwater used. This might be accomplished by changing to irrigated crops that require less water, improving irrigation management practices, limiting groundwater withdrawals, limiting new groundwater development for irrigation, or some combination of these methods. Decreasing groundwater pumpage for irrigation could reduce the number or size of new surface water projects needed to provide irrigation water and recharge the aquifer. Also, decreasing the use of groundwater for irrigation would have an impact on the interchange between surface water and groundwater, perhaps even to the extent of enhancing stream flows.

The model is also capable of simulating other management alternatives and testing the sensitivity of the results to certain kinds of changes. The alternatives that could be evaluated include management of surface water and groundwater supplies, operations of municipalities and industries, and changes in agricultural production practices as well as alternative ways of managing wildlife habitat.

POTENTIAL USES OF THE MODEL

The model currently can be used to address a wide range of alternatives, but the potential uses could be increased. There are two areas in which potential uses of the model might be most appropriate. One is testing the sensitivity of the model output to changes in specified relationships. This would give everyone a better understanding of the relationships in the model. It could also be useful to the modelers in improving those relationships. The other area is expanding the kinds of actions the model can simulate that might be useful in management of the river system.

Sensitivity analyses could be conducted to test the effect of different rates of groundwater irrigation development on model outputs. The rate is directly or indirectly related to groundwater withdrawals, agricultural production and income, and the amount of nitrates in the aquifer. Changing the rate of groundwater irrigation development and observing the change in each of these factors may reveal whether or not the relationships are plausible. If the relationships are acceptable, results can be examined to see how responsive or sensitive certain factors are to the rate of irrigation development. If, for instance, the development rate is reduced by 50 percent and groundwater declines over time are reduced by only 10 percent, the conclusion might be that control of the rate of development

Table 9
EXAMPLES OF SENSITIVITY ANALYSIS

Parameters	Level of Effort 1/
1. Hydrologic Parameters:	
Storage Coefficients, Stream Records	Low
Groundwater Movement	Moderate
2. Environmental Parameters:	
Nitrate Contribution from Agriculture	Low
Relationship of Crane Habitat to Flows	Low
Adjustment of Fishing Days by Fish Habitat	Low
Stream Flow Impact on Channel Width	Low
3. Agricultural Parameters:	
Crop Yields, Water Requirements	Low
Irrigation Development Rate	Low
Cropping Patterns	Low
4. Socio-Economic Parameters:	
Population Growth Rate	Low
Crop Prices, Energy Prices	Low
Construction Cost Index	Low
Population-Employment-Output Relationship	Low

1/Low = 2 weeks or less, Moderate = 2 weeks to 2 months

Table 10

EXAMPLES OF ACTIONS

	Actions	Level of Effort 1/
1.	Evaluate Single Development Options, as Currently Specified	Low
2.	Evaluate Modified Single Development Options	Moderate
3.	Evaluate Multiple Development Options (Combinations of Projects Currently Being Considered)	High
4.	Evaluate New Project Proposals	Very High
5.	Evaluate the Impact of Streamflow Constraints on the Outcome of Already Specified Development Options	Low
6.	Evaluate the Impacts of Non-Structural Alternatives Such as Reduced Tillage	Very High

1/Low = 2 weeks or less, Moderate = 2 weeks to 2 months, High = 2 to 6 months, Very High = 6 to 12 months

is not a very effective way to conserve groundwater resources.

Building additional reservoirs to increase storage capacity would be an example of an action that could be explored with the simulation model. Additional water might be stored during wet years and off season periods. This storage could then be used during dry years to provide water for irrigation or instream flows needed to enhance or maintain wildlife habitat and recreational uses of the river.

These potential uses would probably require two weeks to two months for model modifications. Other potential uses would require modifications of varying complexity needing a wide range of time and effort. Additional examples are given in Tables 9 and 10.

Limitations and Needs

The effectiveness of the Forum process could be diminished by the willingness of the people who use it to participate and interact, or by the capability of the simulation model to accurately represent various dimensions of the river system. The current simulation model, like any computer model, has limitations that affect its ability to accurately represent various dimensions of the Platte River system. These limitations require that the user understand them and use the model only within its capability and that interpretation of the results includes recognition of the limitations. Some limitations of the model are caused by lack of data or lack of a method to represent certain relationships. Other limitations are caused by the lack of time to gather data and prepare the model. In some instances limitations are caused by the need to have a model that is easily understood so that non-technical users will have confidence in the results.

WATER QUALITY

The model has very limited capability in the broad area of water quality. Water quality for domestic and livestock purposes is of greatest concern. Though these uses are only a small part of total water use in the Platte River system, the consequences of drinking contaminated water magnify their importance. Therefore the accuracy of the results of the water quality indicator in the model is also important.

Accurately estimating future water quality is not possible with the current model. Available data is inadequate, and reliable methods for modeling some contaminants in the Platte valley groundwater are not available. In addition, some modeling techniques that would help project groundwater flows in the vicinity of the Platte River and adjacent well fields are so complex and so detailed that they cannot be incorporated into the model in their entirety. As a result, the most desirable indicators of water quality could not be modeled, and a substitute that was barely satisfactory had to be used. For instance, the crude measure used to indicate potential water quality in the Grand Island well field near the Platte River is the number of days in which there is no flow in the stream. This is only one of many factors that influence the well field, but it was attainable, so the participants settled on it as an indicator, not a measure.

Another need is for data concerning loss of nitrate-nitrogen from agricultural lands. Currently, losses in the model are average values that are used over large land areas. This measure may misstate those losses because of differences in soils, cropping patterns and the amount of water that percolates to groundwater. If the average nitrate-nitrogen losses are correct, there is still the problem of what happens to them as they move toward the water table and after they reach it. At present there are no methods for modeling all the processes that nitrate-nitrogen goes through as it is leached into the groundwater.

Considerable effort is needed to improve the water quality component of the model. Data on nitrate leaching losses and nitrate reaching the groundwater are needed. Data on the mixing of the nitrates in the groundwater and possible denitrification below the water table are required. In addition, methods of accurately modeling the movement of nitrates in the groundwater that account for denitrification must be

developed. This type of model, like the model of groundwater flow around the Grand Island well field currently being developed elsewhere, would be too complex, too large, and too detailed to be part of the Forum model. In these cases, some method of relating their results to the results of the Forum model is needed.

ECONOMIC LIMITATIONS

Another limitation of the model is its capability to estimate economic impacts of alternative management actions. It is particularly severe for estimating impacts associated with proposed irrigation projects.

One problem related to economic analyses is lack of comparable construction, operation, and maintenance cost data for all proposed irrigation projects. The current data was compiled by different groups at different times and in some cases they are merely guesses. Comparison of projects when cost estimates are incompatible is risky, if not impossible.

A change in the value of output in a sector of the economy is called a direct economic impact. The change may be caused by something like a new government policy, a new irrigation project or extreme weather conditions. The change experienced by other sectors as a result of the initial impact is labelled indirect economic impact.

Indirect economic impacts are calculated in the model by applying a multiplier to direct economic impacts. The current estimate of multipliers was developed by adjusting a statewide multiplier to reflect regional differences. The adjustment was made with informed judgment because there wasn't time to collect data and prepare it for use in the model. Regional differences in these multipliers may or may not reflect actual differences. Therefore indirect economic impacts of various actions could be grossly

misstated and compounded by errors from other sources.

Another problem in economic impacts estimation is the calculation of recreation benefits. The major problem in this area is lack of data for estimating recreation uses of the river and adjoining lands. The current model only makes estimates of fishing and hunting use. No estimates are made for boating, picnicking, camping or wildlife viewing. Also no data were available to develop any relationship between the amount of water flowing in the stream and the rate of recreation use.

The limitations of the economic impact section of the model can be reduced. The problem of inconsistent cost data can be minimized by making appraisal level studies of the proposed projects. The resulting estimates, although not exact, would allow better comparison of projects.

Efforts are being made to update and refine an Input-Output model for Nebraska that will make it possible to develop accurate multipliers. These multipliers can be used in the simulation model to estimate more accurate indirect economic impacts.

Much work has been done to understand the recreational uses of water and land in and around reservoirs. Relationships have been developed that relate the rate of recreation on reservoirs to population density, surface area of the reservoir and proportions of the population that use reservoirs for various activities. Similar data collection and generation of relationships needs to be done for recreation uses of streams. This would make it possible to improve estimates of recreation benefits with the model.

RECREATION/WILDLIFE

Much of the conflict about the use of the Platte River is between those who support proposed irrigation projects and those who contend that the river is critical habitat for certain wildlife species. Therefore one of the more significant aspects of the model is the one that estimates the effects of various actions on the wildlife and habitat of the system. That aspect currently is significantly weak, although useful.

Most of the limitations in calculating measures of wildlife indicators stem from lack of data. Among the data needs is information regarding nesting habitat for least terns. They seem to prefer in-channel sandbars for nesting purposes but little is known about where and if they do nest when sandbars are not available. Additional data concerning habitat needs of fish, eagles, and cranes and the relative habitat values of various in-stream flows is also needed. Some data was available, for specific locations, so it was incorporated into the model. The Nebraska Game and Parks Commission and the Fish and Wildlife Service were collecting this data for other locations, and it should be added to the model when it becomes available.

POTENTIAL FOR IMPROVEMENT

This model, like any model, has limitations. It also has positive attributes. It has been designed to provide the kinds of information that managers and policymakers said they needed and could understand. That information can now be improved. Some of the needed data and methods can now be added, and more can be added as time and funds are available. Improving the model and the information it produces can be a continuing process as long as the output is useful to those who need it.

The model and its outputs would be most useful if employed in an interactive process like the Platte River Forum. The Adaptive Environmental Assessment process, on which the Forum was based, has been proven to be effective in other areas. It could be productive in this situation in the future. If it is not possible to organize a new group to interact as required by the AEA process, however, the improved and expanded model and the core team could still provide better information for future decisions.