IOWA
WATER PLAN '78
THE FRAMEWORK STUDY—SUMMARY REPORT

IOWA'S
STATE WATER PLAN
PHASE I

- IDENTIFICATION OF PROBLEMS AND NEEDS
- POLICY AND PROGRAM ELEMENTS

JULY 1978

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Iowa
a place to grow

July 1978

GOVERNOR Robert D. Ray
MEMBERS of the LEGISLATURE
and THE PEOPLE OF IOWA

We are submitting herewith the Iowa Natural Resources Council's Water Plan 78, the main report of the State Water Plan Framework Study. This report is the culmination of the three-year cooperative effort between this agency and the Department of Environmental Quality, Conservation Commission, Department of Soil Conservation, and the Geological Survey, funded by the Legislature in 1978.

The report addresses major water problems in nine functional areas and recommends policy, programs, and legislative proposals to solve those problems. It will be the baseline from which detailed implementation planning will evolve in Phase II of the State Water Plan effort.

Sincerely,

James R. Webb
Director

Merwin D. Dougal
Chairman

PREFACE

This Framework Study, written under the auspices of the Iowa Natural Resources Council, is dedicated to the people of the State of Iowa The report represents a culmination of a three year project designed to better control, utilize, and protect Iowa's water resources.

The Natural Resources Council would like to acknowledge the following groups for their assistance in preparing the Study: the Iowa Geological Survey; Iowa Department of Environmental Quality, Iowa Department of Agriculture; Iowa State Historical Department, Division of Historic Preservation; Iowa Conservation Commission; Iowa Development Commission, Department of Soil Conservation; Energy Policy Council, Citizen's Advisory Committee, U.S. Army Corps of Engineers; U.S. Soil Conservation Service; United States Geological Survey; U.S. Weather Service; Federal Insurance Administration; and Iowa State University.

Further acknowledgement is made to the numerous individuals who aided in the research and preparation of this report.

Preparation and publication of this report was supported in part by grants
made by the Federal Water Resources Council
under Title III of the 1965 Water Resources Planning Act.

Water Policy Goals Mandated
By Chapter 455A, Code of Iowa:

- that the water resources of the state be put to beneficial use to the fullest extent of which they are capable;
- that the waste, unreasonable use, or unreasonable methods of use of water be prevented;
- that the conservation of the state's waters be exercised with a view to assuring the reasonable and beneficial use thereof in the interest of the people;
- that the public and private funds for the promotion and expansion of the beneficial use of water resources shall be invested to the end that the best interests and welfare of the people are served;
- that the state's water resources agency shall have the duty and authority to establish and enforce an appropriate comprehensive state-wide program for the control, utilization, and protection of the surface and groundwater resources of the state;
- that the protection of life and property from floods, the prevention of damage to lands therefrom, and the orderly development, wise use, protection, and conservation of the water resources of the state by the considered and proper use thereof (by beneficial user groups), is of paramount importance to the welfare and prosperity of the people of the state;
- that the comprehensive, statewide plan for the control, utilization, and protection of the water resources of the state shall include all uses and developments of water resources, and shall provide for the optimum control, protection, development, allocation, and utilization thereof;
- that the plan shall give consideration specifically to the needs of domestic households, municipal corporations, agriculture, industry, fish and wildlife, recreation, health, pollution control, and allied matters (including energy production and border river navigation) as they relate to water resources and flood control; further, that the use of water for domestic purposes (drinking water and ordinary household use) and for ordinary numbers (family-farm sustenance) of poultry, livestock, and domestic animals shall have priority over other uses (with a balancing of priorities among other users in a regional and/or groundwater aquifer sense);
- that water occurring in any underground basins (aquifers) or in any watercourse, or other natural body of water of the state, is declared to be public water and public wealth of the people of the state of Iowa and subject to beneficial use in accordance with the statutory provisions (and departmental rules and procedures) for regulated and unregulated uses;
- that no use of water shall be authorized that will impair the effect of pollution control laws as they apply both to the surface waters and the groundwater aquifers of the state, or impair or deplete the established average minimum in-stream flow (protected low flow).

COVER: Iowa Farm Pond, K. Formanek

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Water — A Vital Resource

In the past, Iowa's favorable climate and geology have provided plentiful water to meet the needs of most areas of the state. However, periods of drought and flood have placed severe stress on the state's economy and on affected individuals. Today, growing demands on our water resources create conflict between classes of users as each sector attempts to meet its demands for larger and more reliable supplies. Furthermore, accelerated development of flood-prone areas for agriculture, industry, and residential use creates demands for expanded flood protection, a situation that calls attention to the need for increased regulation of flood plain occupancy.

Problems growing out of water shortages or surpluses cannot be viewed as isolated cases. Water resource uses continually interact and sometimes conflict with other activities; some examples follow illustrating these conflicts:

1. **Drainage of wetlands:** Many areas could be brought into agricultural production if the land were properly drained, or streams straightened and timber cleared. However, such actions destroy wildlife habitat and may have adverse effects on downstream flooding. The remaining wetlands are critical to migratory waterfowl and to a variety of other plants and animals that are essential for maintaining an ecologicial balance.

2. **Waste disposal in streams:** Streams have the ability to assimilate safely a variety of waste materials, particularly the effluent from water pollution control plants. However, continued uncontrolled use of these waters to dispose of municipal, industrial, and agricultural wastes will exceed the safe capacity and further degrade their quality, making them unsuitable for many other uses including water supply and recreation.

3. **Reservoir construction:** Reservoirs can help solve flood problems and supply water for domestic and industrial uses. They also provide additional acreage for water-oriented recreation, although many users prefer natural, free-flowing rivers to artificial lakes. In addition, there are adverse effects associated with destruction of riverine habitat and the adverse impact of pool fluctuations on shorelines.

Goals and Scope of a State Water Plan

Chapter 455A, Code of Iowa, dictates the water policy goals to be achieved in a state water plan. These goals are listed at the beginning of this report. In summary, the mandate is to develop a plan to put the surface and groundwater resources of the state to their fullest beneficial use so that the prosperity, general welfare, and best interest of the state is served. More specifically, this goal may be stated as follows:

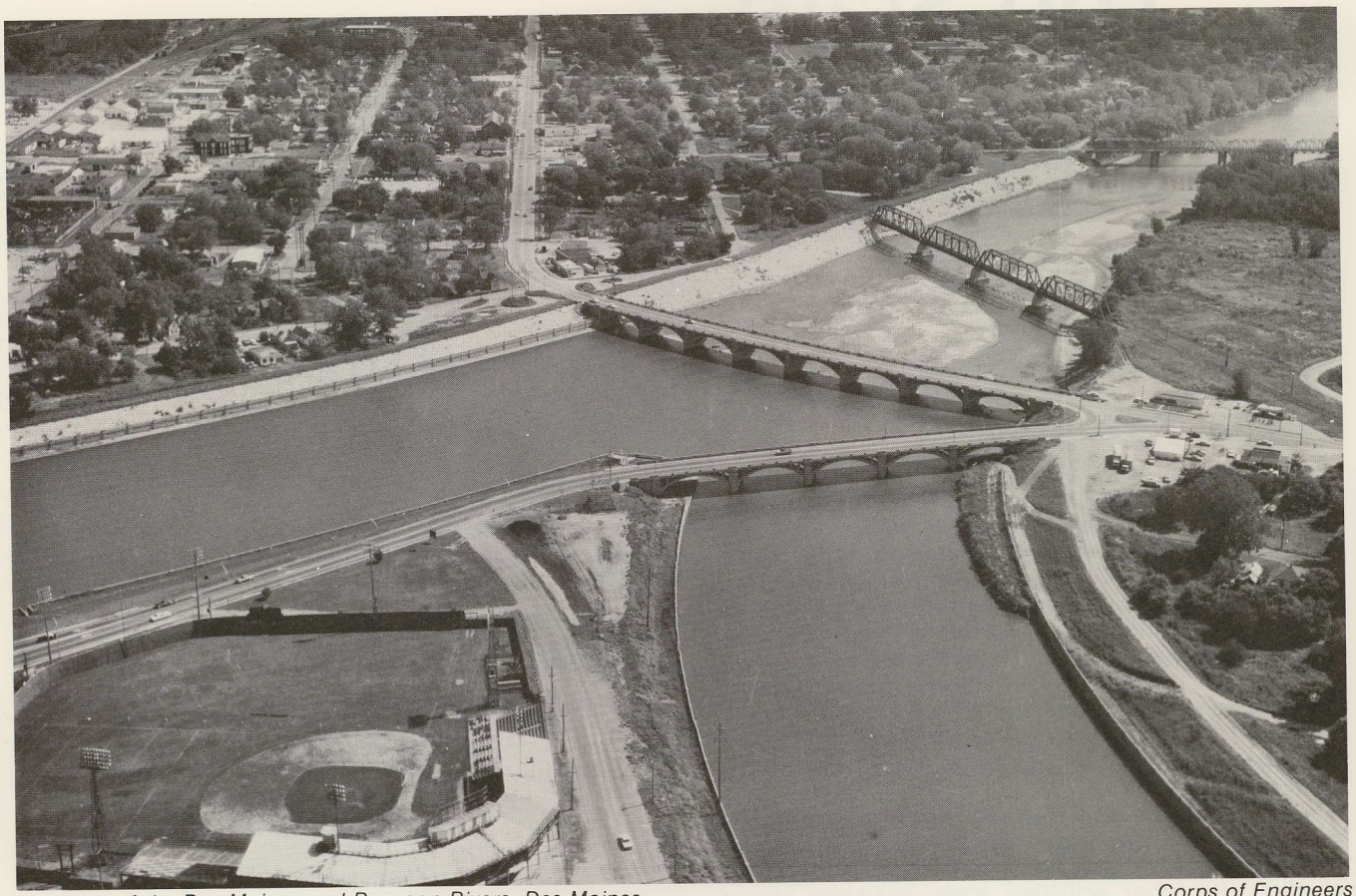
1. To provide for the efficient use of the state's water resources, both now and in the future.
2. To conserve water and related land resources of the state and prevent waste.
3. To provide an adequate and safe water supply for existing and future use to meet a variety of demands.
4. To protect and enhance the quality of water in the state.
5. To consider interrelationships among social, economic, and enrivonmental values, and reduce adverse impacts caused by conflicts.

Water Plan '78 — Framework Study is the initial effort to fulfill the goals listed above. It is confined to a study and evaluation of existing data, and to recommendations of policies and programs for future, more detailed regional, county, and local planning and development projects. Ultimately, it may help solve these problems identified in this study.

Participants in the Planning Process

The principal working group, the Technical Coordinating Committee (TCC), was formed in 1975 to provide technological guidance and coordinate efforts to participating agencies and task forces. The TCC was comprised of representatives from those state agencies concerned with natural resources, including the following:

Department of Environmental Quality
Department of Soil Conservation
Iowa Conservation Commission
Iowa Geological Survey
Iowa Natural Resources Council
Office for Planning and Programming
Energy Policy Council
Department of Transportation



Junction of the Des Moines and Raccoon Rivers, Des Moines *Corps of Engineers*

Representatives from the Attorney General's Office and the Iowa State Water Resources Research Institute served as advisors to the TCC.

Task Force Membership

Members of the individual task forces were selected for their expertise in their particular water use area. Representatives from state and federal agencies, as well as from the private sector, were included. A representative from the Technical Coordinating Committee and Iowa Natural Resources Council planning staff provided the leadership for the individual task forces. Contributing agencies and groups, other than those listed above, include:

State Agencies

Iowa Commerce Commission
Iowa Department of Agriculture
Iowa Development Commission
State Office of Disaster Services
Iowa State University and the
Water Resources Research Institute
University of Iowa and the
Iowa Institute for Hydraulic Research
State Hygienic Laboratory

Federal Agencies

U.S. Fish and Wildlife Service
U.S. Department of Housing and
Urban Development
U.S. Geological Survey
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Environmental Protection Agency
U.S. Soil Conservation Service
U.S. National Weather Service

Other Groups

Iowa Association of Rural Water Districts
Mid-America Power Pool
Iowa Utility Association
The Izaak Walton League of America
Several community and local agencies.

Task Force Reports

Task forces were selected to develop the basic information necessary for evaluating the water resources of Iowa. Seven reports were developed by experts in their fields, analyzing the following categories of water management and use according to the goals listed under each heading:

Water Quality

1. To protect the quality of the surface and groundwater resources for the beneficial use of the citizens of Iowa.
2. To improve the aesthetics of Iowa rivers and lakes and to protect, enhance, and maintain aquatic life and recreational opportunities.

Domestic, Municipal, Commercial, and Industrial Water Supply

1. To ensure water supplies of adequate quantity and quality to meet short and long range needs.
2. To ensure that all citizens are served by adequate supplies of potable water to enhance their health and well-being.

Flood Plain Management

1. To guide an orderly development and effective management of the flood plains in the state, within a design that will minimize the intensive urban occupancy of these flood plains in the future.
2. To protect against needless loss of life and reduce damages to land and property by floods.

Water-Oriented Recreation and Fish and Wildlife

1. To assure a quality water-oriented recreation experience for present and future generations of Iowans by providing water and related land resources of sufficient quantity and quality to meet present and future needs.
2. To enhance or improve the quality of the natural, scenic, fish and wildlife resources, and preserve the remaining wetlands and unique scenic or sensitive water and related land areas for the benefit of all.

Water for Energy Production

1. To enhance economic development in Iowa by providing the quanity and quality of water

Channelization of Little Sioux River, Harrison County *Corps of Engineers*

needed to meet present and future needs for energy production.

2. To enhance the quality of Iowa's environment through the proper management of water and related resources used for energy production.

Commercial and Recreational Navigation

1. To enhance economic development by use of commercial river navigation and barge terminal facilities as necessitated by concerns for economic efficiency.
2. To enhance the quality of the border river corridors for recreation and other uses, and restoration of the quality of certain natural and cultural resources and ecological systems.

Agriculture

1. To improve the economic well-being of Iowa;
   (a) by providing the quantity and quality of water required as an input for agricultural production levels determined by commodity demands, and
   (b) by improving water use efficiency by agriculture in the state.
2. To enhance the quality of Iowa's environment through the management, conservation, or improvement in quality of the natural, cultural, or ecological resources affected by agricultural production and related water use. Included are the related land use relationships and soil and water conservation practices affecting the future of Iowans.

Additional task force reports were developed by support groups to furnish basic data and background information for use in the water use and management reports. Included in these supporting documents are:

Data Base and Needs

1. To establish a common boundary for delineation of hydrologic boundaries, and to assure that common units are utilized by other task forces.
2. To examine data shortages, data use, and data needs pertaining to Iowa's water resources.

Water Resources Availability

1. To review the systems used for collection and analysis of basic water and related land resources data.
2. To determine location and availability of the surface and groundwater resources within the state.
3. To compile information of quantity and quality of Iowa's water resources for use by other task forces.

Socio-Economic and Legal and Institutional Aspects of Water Resources (Law and Government)

1. To examine present legal, institutional, demographic, and socio-economic trends.
2. To relate these policies, laws, and trends to the projected demands on water and related land resources.

The seven task force reports dealing with management and use, and the four background studies on Basic Data Needs, Water Availability, Socio-Economic Aspects, and Law and Government are available on request from the Iowa Natural Resources Council.

2 Iowa's Water Resources

In Iowa, water is now used at a rate of 60 to 150 gallons per capita per day (gpcd), varying with the size and economic characteristics of communities. In 1970, the total water withdrawn from surface and ground water sources was about 2.5 million acre-feet, or about 2 billion gallons per day. By 1975, this amount more than doubled to 5 million acre-feet, and is projected to reach at least 10 million acre-feet by the mid 1990s (Barnard and Dent, 1976, Projections of Population, Employment, Income and Water Use for Iowa River Basins, 1975–2020).

Iowans have accepted a philosophy of water development based on faith in natural abundance and renewability of supply. By and large, nature has provided abundantly, except for episodes of drought experienced during the 1930s, and 1950s, and again in the 1970s. However, this philosophy has not been totally satisfactory to all users in the state, and holding to it has caused some unfortunate precidents to be set in water resource management and development. Conflicts between water users are becoming much more common as each sector attempts to meet its demands for larger and more reliable water supplies.

Iowans are only beginning to feel the impact of the inbalance between water supply and demand. Very soon water managers and developers must address the issue of water resources allocation which, in the past, was of concern only in those states with less abundant water supplies.

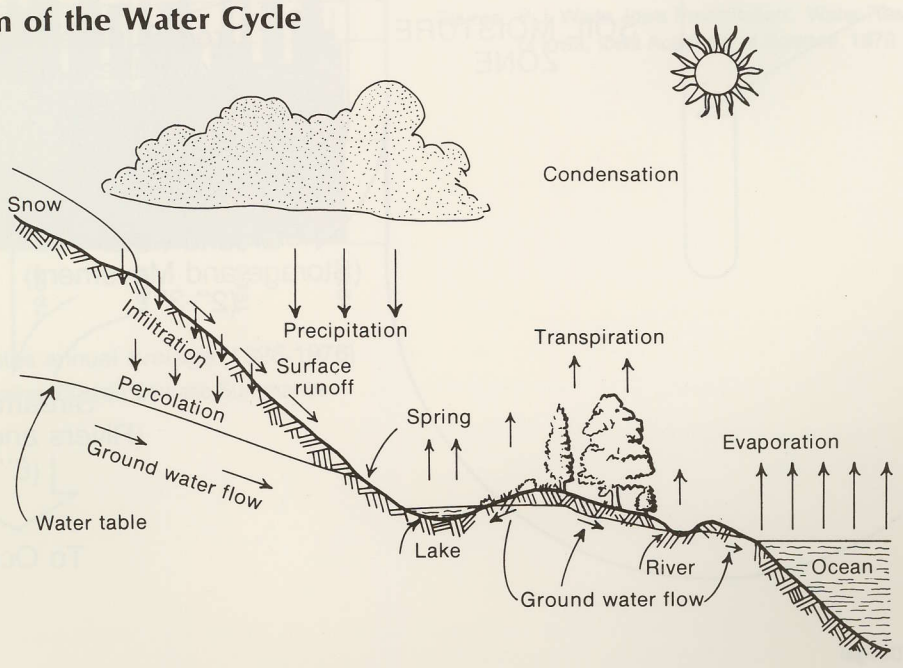
What then is this water resource that Iowans must protect, conserve, manage, and allocate?

The Water Cycle

The earth's water is constantly in motion, from the oceans to the atmosphere, to the land, and back to the oceans, as shown schematically in Figure 1.

Most of the precipitation that falls in Iowa infiltrates through the ground surface into the soil profile. Of the annual 32 inches (800 mm) of precipitation, about 75 percent is returned by evapotranspiration (evaporation and transpiration by plants). About 20 percent of this precipitation becomes runoff, eventually leaving the state as streamflow. The remaining few percent percolates slowly downward beyond the soil moisture zone to become groundwater. During dry periods, the majority of perennial streams owe most or all of their flow to the discharge of groundwater back to the surface. Figure 2 summarizes the movement of water in Iowa's hydrologic cycle. Water resources planning requires a detailed knowledge of all aspects of the water cycle.

FIGURE 1 Diagram of the Water Cycle



Climate

Climate is the most variable of the elements involved in the supply of water within the state. Iowa's "normal" climate approaches the optimum for agriculture, and would assure a plentiful supply of water; but, the normal climate, in the sense of "average", is rarely experienced. Major and prolonged departures from statistical normal climate may have serious consequences (Figure 3).

Deficiencies of precipitation may cause reduced crop yields, or even crop failures, and may cause local water shortages. Excesses often produce destructive floods. Particularly critical are extreme heat, prolonged droughts, periods of excessive precipitation, damaging winds, and unseasonably low temperatures that produce early and late frosts.

If atmospheric patterns change frequently, weather alternates between moist and dry and warm and cool, generally benefiting growing crops. If a particular pattern becomes established for too long a time, we may be faced with prolonged drought, excessive precipitation and floods, or extended periods of extreme cold or heat. Many climatologists believe that weather patterns have been unusually favorable for agriculture throughout most of the present century, particularly during the last 10 to 20 years; what the climatic future holds is subject to considerable debate.

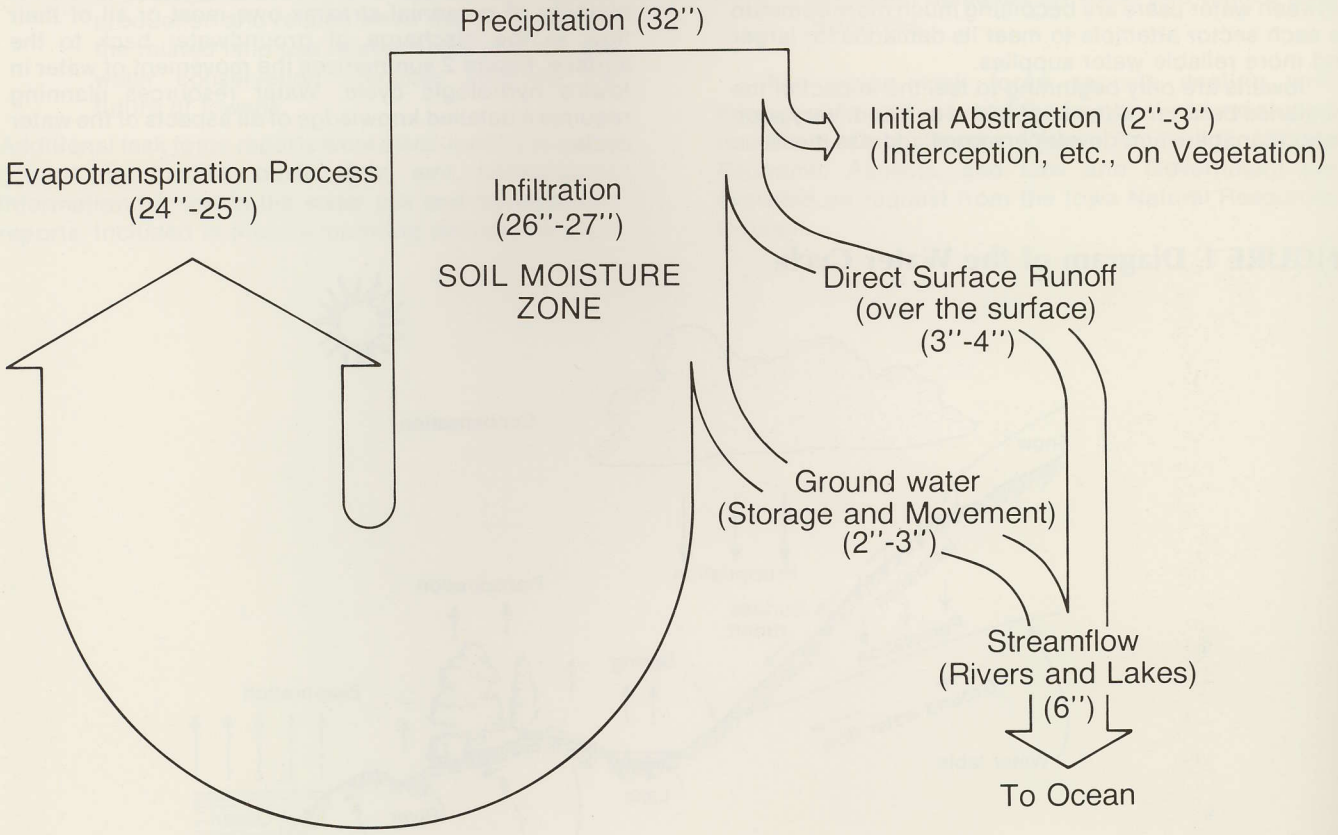
Evapotranspiration and Iowa's Water Budget

Evapotranspiration is the total loss of moisture from land and water surfaces to the atmosphere. It includes the loss through evaporation from free-water surfaces, moist soil, and from vegetation. A plant extracts soil moisture through its roots, circulates it through the plant tissues, and transpires it into the atmosphere from leaf surfaces.

Temperature plays an important role in water resource availability since the effectiveness of precipitation is, in part, a function of temperature. High temperatures mean increased evapotranspiration. Potential evapotranspiration (PE) in Iowa generally exceeds normal precipitation during June, July, August, and September; thus, runoff and groundwater recharge is minimal or nonexistent during most summers, although this period has the most precipitation in an average year. Under normal summer conditions, daily water loss may reach 0.2 to 0.3 inches, and 0.5 inches may be lost on a hot, windy day. Iowa farmers appreciate an inch of rainfall each week during the growing season.

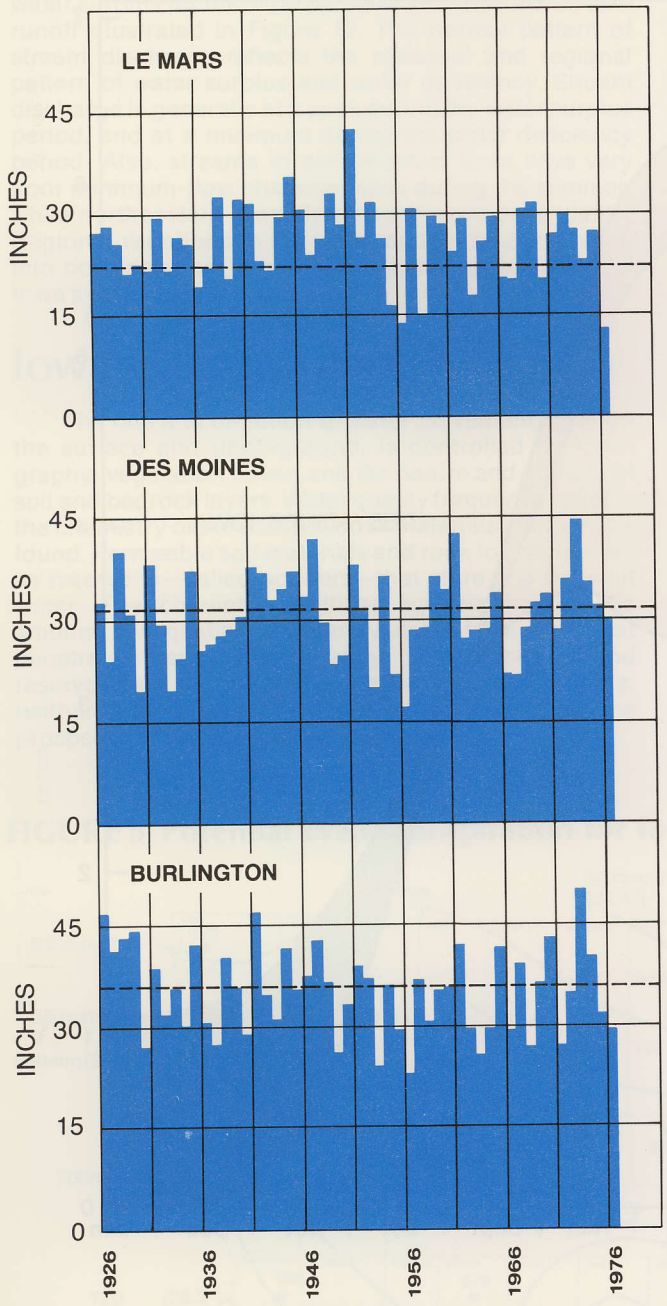
Figure 4 summarizes the water budget for Des Moines in graphic form. Actual evapotranspiration (AE) and PE are equal so long as there is a water surplus as in the case for Des Moines between October and May. From June through September, PE exceeds the moisture available, and the rate of AE is estimated to be

FIGURE 2 Movement of Water In Iowa's Hydrologic Cycle



Source: Merwin D. Dougal

FIGURE 3 Comparision of Precipitation, 1926-1976, for Iowa Stations

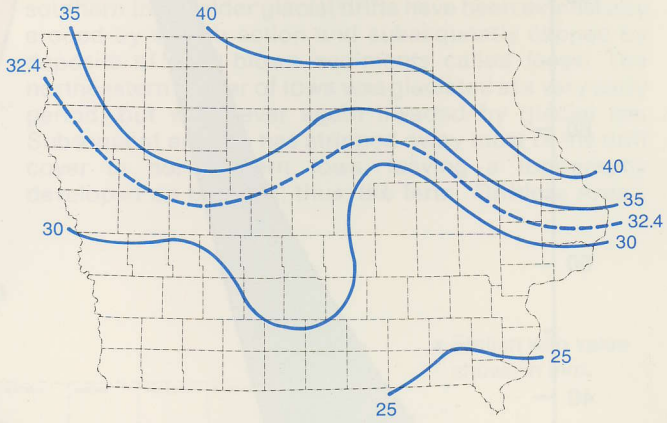


Dash line indicates annual average (1926-1976)
Source: U.S. Weather Bureau Climatic Summaries

proportional to the available soil moisture—that is, if soil moisture is at 60 percent of capacity, the rate of evapotranspiration will be about 60 percent of PE.

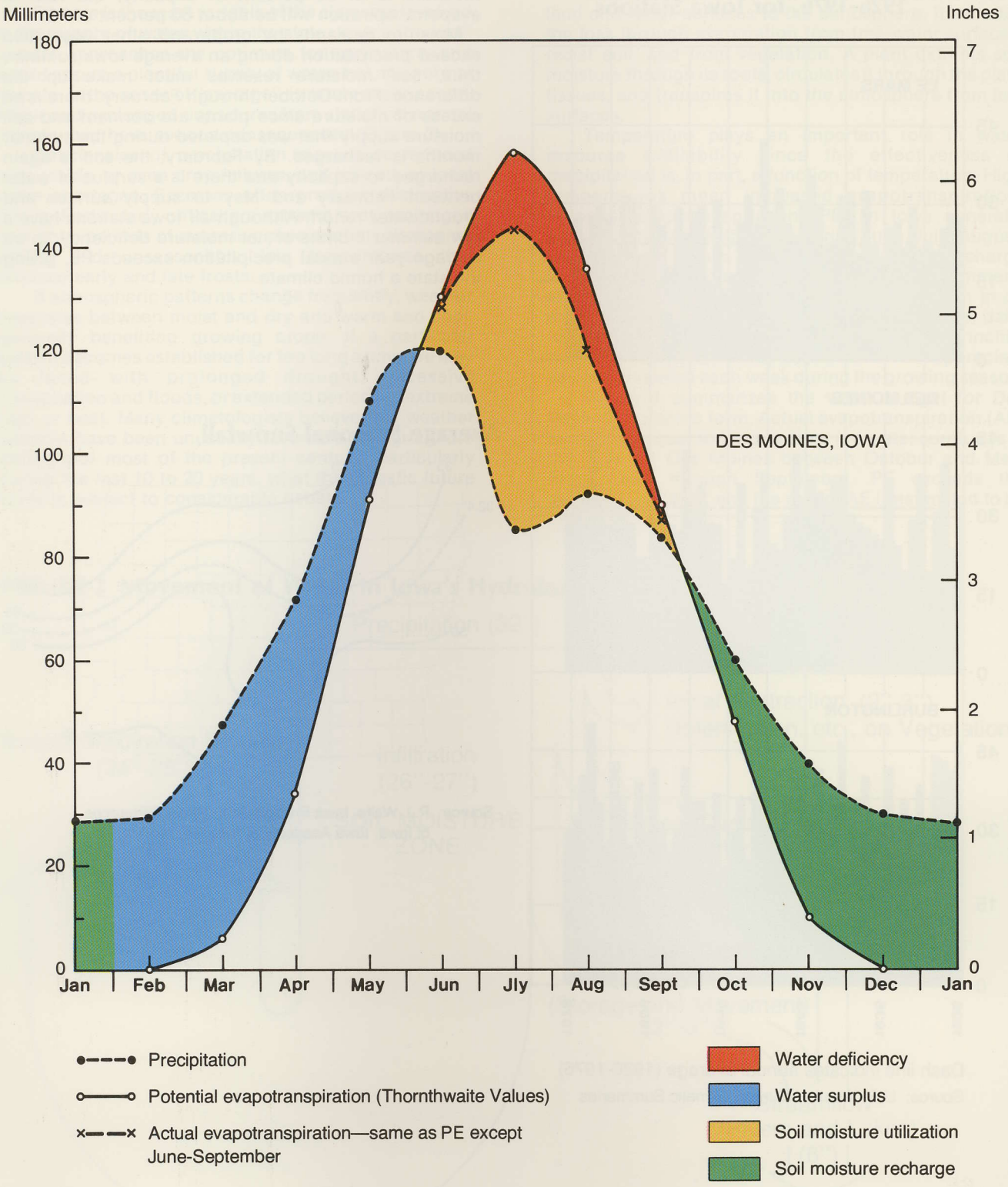
Moisture demands by crops and other vegetation exceed precipitation during an average Iowa summer; thus, soil moisture reserves must make up the difference. From October through February, there is an excess of moisture since plants are dormant and soil moisture supply that was depleted during the summer months is recharged. By February, the soil is again recharged to capacity and there is a surplus of water between February and May to supply surface and groundwater runoff. Although all Iowa stations have a few summer months of net moisture deficiency, in an average year annual precipitation exceeds PE, giving the state a humid climate.

Average Seasonal Snowfall



Source: P.J. Waite, Iowa Precipitation: Water Resources of Iowa, Iowa Academy of Science, 1970.

FIGURE 4 Water Budget for Des Moines



Figures 5, 6, and 7, depict the state pattern of average annual PE, average water surplus from March through May, and average water deficiency from June through September. The pattern and magnitude of the water surplus for the state parallels the pattern of stream runoff illustrated in Figure 12. The normal pattern of stream discharge reflects the seasonal and regional pattern of water surplus and water deficiency. Stream discharge is generally at a peak during the water surplus period, and at a minimum during the water deficiency period. Also, streams in northwestern Iowa have very poor minimum-flow characteristics during the summer, while northeastern Iowa streams are more dependable. Regional variations in the water budget must be taken into consideration in planning for the optimum use of Iowa's water resources.

Iowa Geology and Hydrology

The rate and direction of water movement, both on the surface and underground, is controlled by topography, vegetation cover, and the nature and attitude of soil and bedrock layers. Water quality frequently reflects the chemistry of the soils and rock materials in which it is found. Permeable soil materials and rock formations act as reservoirs—called aquifers—that store and transmit water. The character of these aquifers control the amount and quality of water available from wells that penetrate them. Unfortunately, these underground reservoirs are not uniformly distributed across the state; neither is the quality of the water they contain nor the prospects of a given rate of yield.

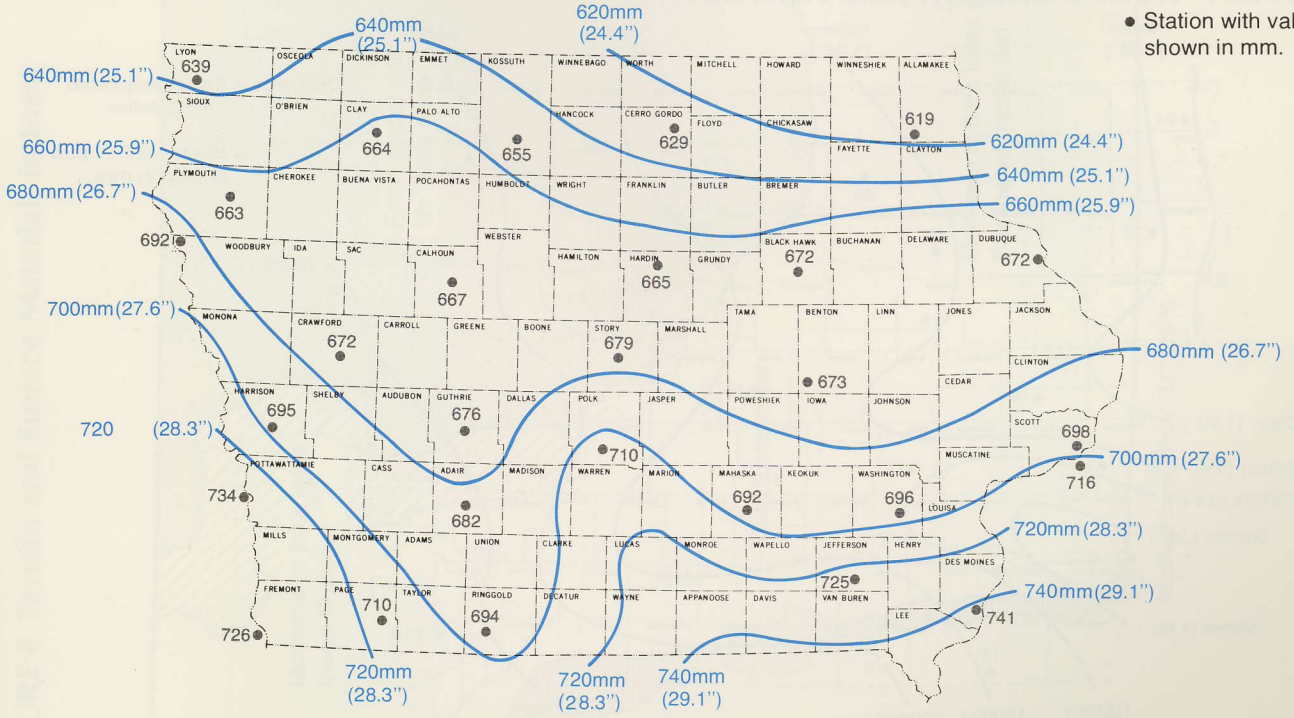
Hydrology and Geology of Groundwater

Iowa landscapes have been formed by the action of water, glacial ice, and wind. The surface features are mostly developed in relatively young, unconsolidated sediments that mantle the bedrock; thus, two vastly different sequences of earth materials, functioning interdependently, form the geologic framework that influences the occurrence of water in the state. The uppermost and youngest of these sequences consist mostly of unconsolidated sediments of glacial origin; the lower and older sequence is formed by alternating layers of consolidated rock, principally limestone, dolostone, shale, and sandstone.

Unconsolidated Sediments

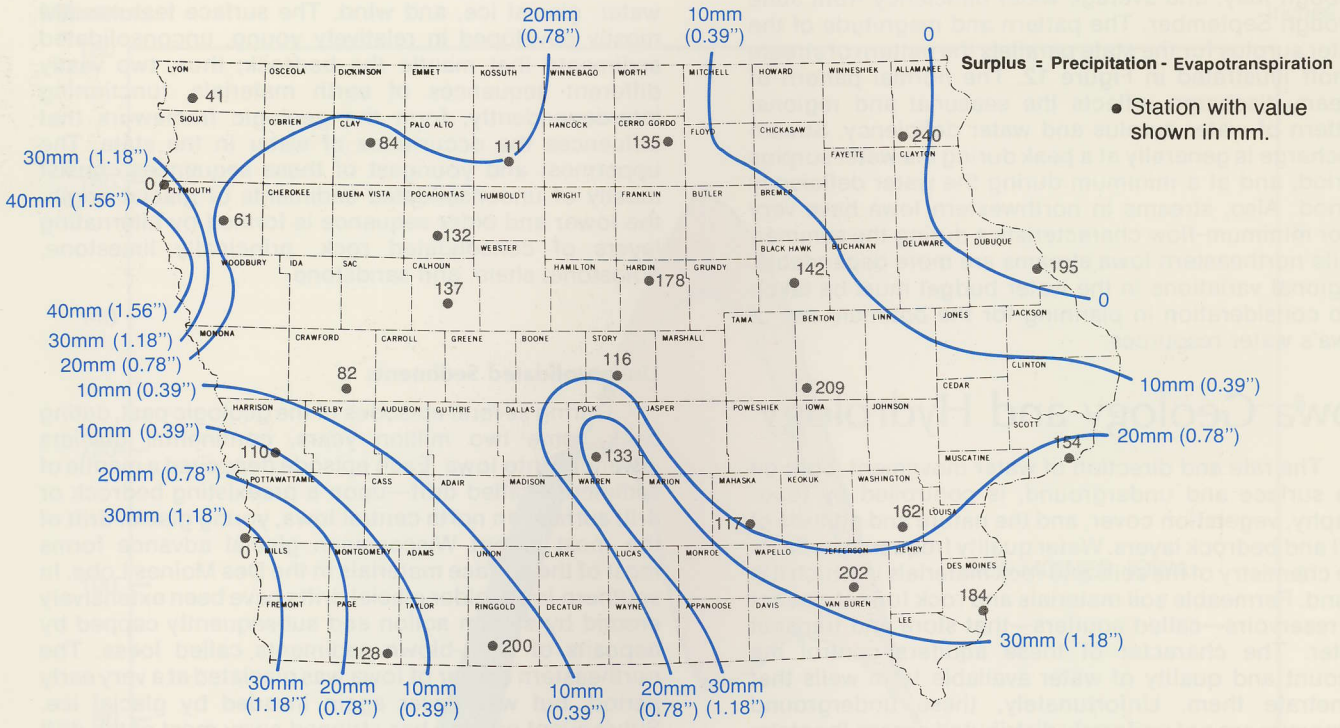
During several episodes of the geologic past, dating back some two million years, continental glaciers advanced into Iowa. Each episode deposited a mantle of sediment—called drift—upon a preexisting bedrock or drift surface. In north central Iowa, young glacial drift of the most recent Wisconsinan glacial advance forms most of the surface materials in the Des Moines Lobe. In southern Iowa, older glacial drifts have been extensively eroded by stream action and subsequently capped by deposits of wind-blown sediments called loess. The northeastern corner of Iowa was glaciated at a very early period, but was never again invaded by glacial ice. Subsequent erosion has stripped away most of the drift cover in northeastern Iowa, leaving a topography developed on bedrock; thus, the term "Driftless Area".

FIGURE 5 Potential Evapotranspiration for Iowa



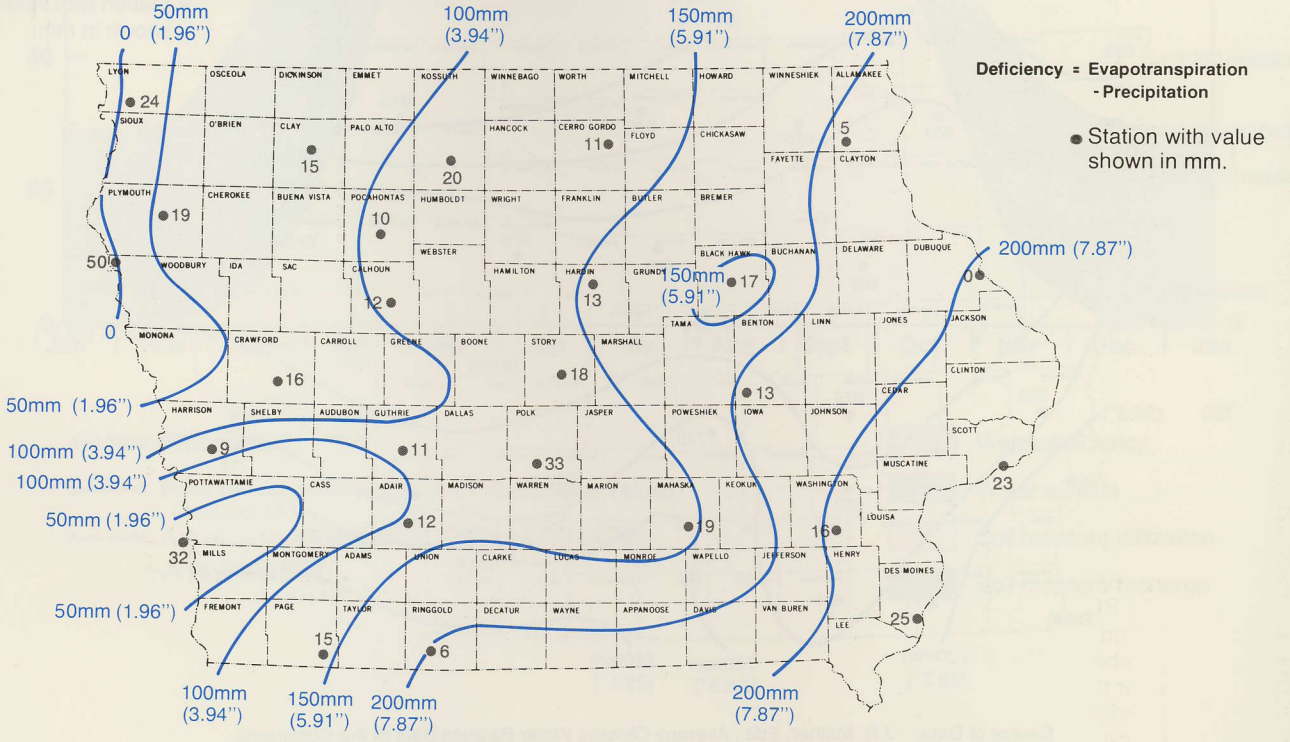
Source of Data: J.R. Mather, Edit., Average Climatic Water Balance Data of the Continents: Part VII United States, C.W. Thornthwaite Assoc., Centerton, N.J., 1964.

FIGURE 6 Water Surplus, March-May



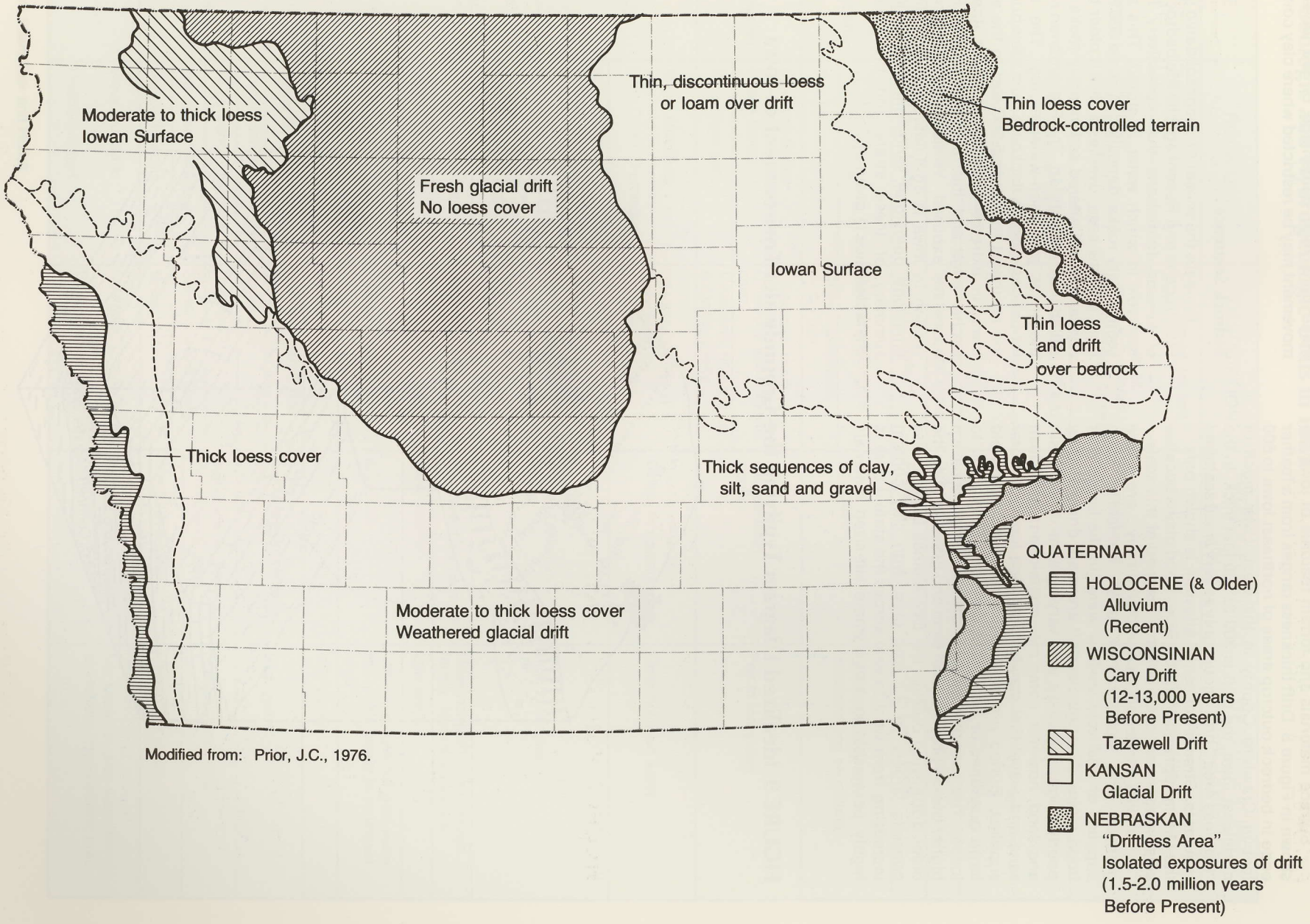
Source of Data: J.R. Mather, Edit., Average Climatic Water Balance Data of the Continents: Part VII United States, C.W. Thornthwaite Assoc., Centerton, N.J., 1964.

FIGURE 7 Water Deficiency, June-September



Source of Data: J.R. Mather, Edit., Average Climatic Water Balance Data of the Continents: Part VII United States, C.W. Thornthwaite Assoc., Centerton, N.J., 1964.

FIGURE 8 Terrain and Surface Materials in Iowa



Modified from: Prior, J.C., 1976.

Surface materials and terrain features of Iowa are shown in Figure 8. Drift thickness ranges from a feather edge in bedrock outcrop areas of northeast Iowa to 600 feet in Crawford County in the west. Over much of northwest Iowa, the drift is 300 to 500 feet thick. In the "Driftless Area", drift occurs only as very small scattered remnants. Stream-deposited alluvium is shown only in the Mississippi and Missouri River flood plains because elsewhere it cannot be suitably mapped at this scale.

Alluvial materials, characteristically, are more granular and well drained, often furnishing large supplies of relatively shallow water in the larger river flood plains. Most glacial drift areas are dominated by poorly permeable clays with varying admixtures of silt and sand; however, some may contain lenses of clean sand and gravel that may furnish good localized water supplies. Buried pre-glacial channels also may yield large quantities of water, but they may be difficult to locate. The younger drifts of north central Iowa have a higher overall proportion of sand and gravel than do the older drifts lying outside the Des Moines Lobe. Loess consists largely of silt and clay, with clay content increasing from west to east across the state. Loess is highly permeable in areas where silt-sized materials make up a high percentage of the loess, but water movement may be restricted where clay content is high.

Bedrock Sequence

Beneath the veneer of unconsolidated sediments of Pleistrocene and Recent age, lie the bedrock consisting of layered formations that collectively form a vast reservoir in which water is stored. This sequence of sedimentary rocks, deposited in some 600 million years from shallow seas, overlies a much older basement of crystalline and altered sedimentary rocks, collectively called the Precambrian. The Precambrian rocks are, for the most part, non-waterbearing. The sedimentary formations range in thickness from a few hundred feet in the northeast to nearly 5,000 feet in the southwest of Iowa. In extreme northwestern Iowa, they thin to a feather edge and the underlying, older Precambrian rocks are exposed. Vertically, the sedimentary rock section in Iowa is dominated by alternating strata of limestone, dolostone, sandstone, and shale. A detailed summary of these strata and their water bearing characteristics is given in Table 1.

FIGURE 9 Idealized Diagram Typifying the Groundwater Environment of Iowa

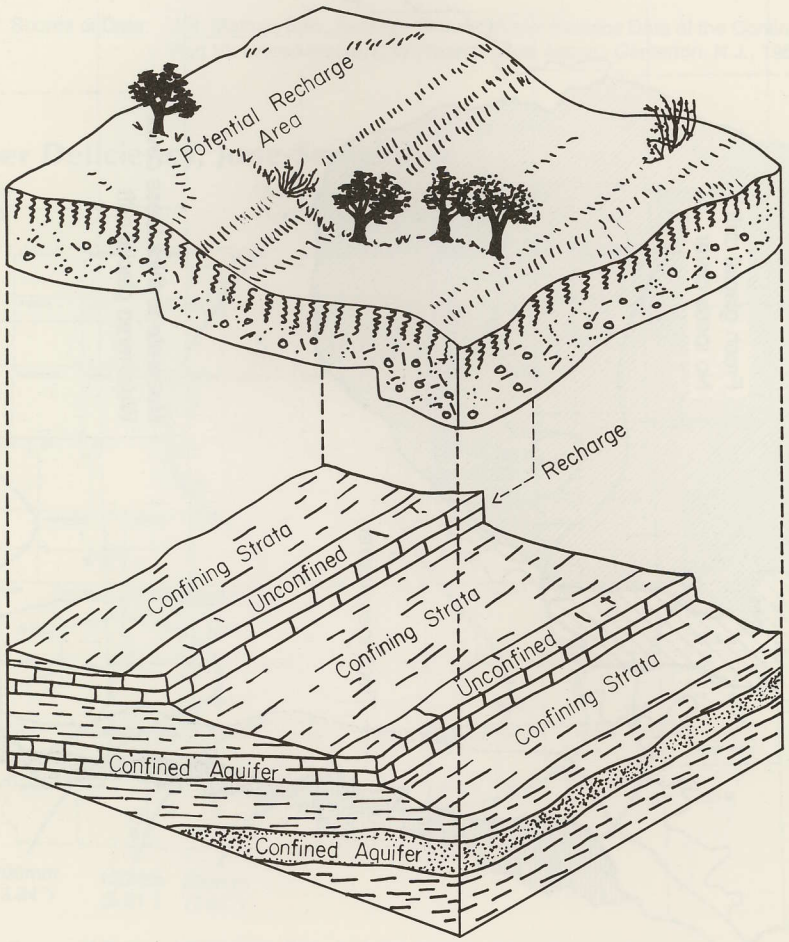
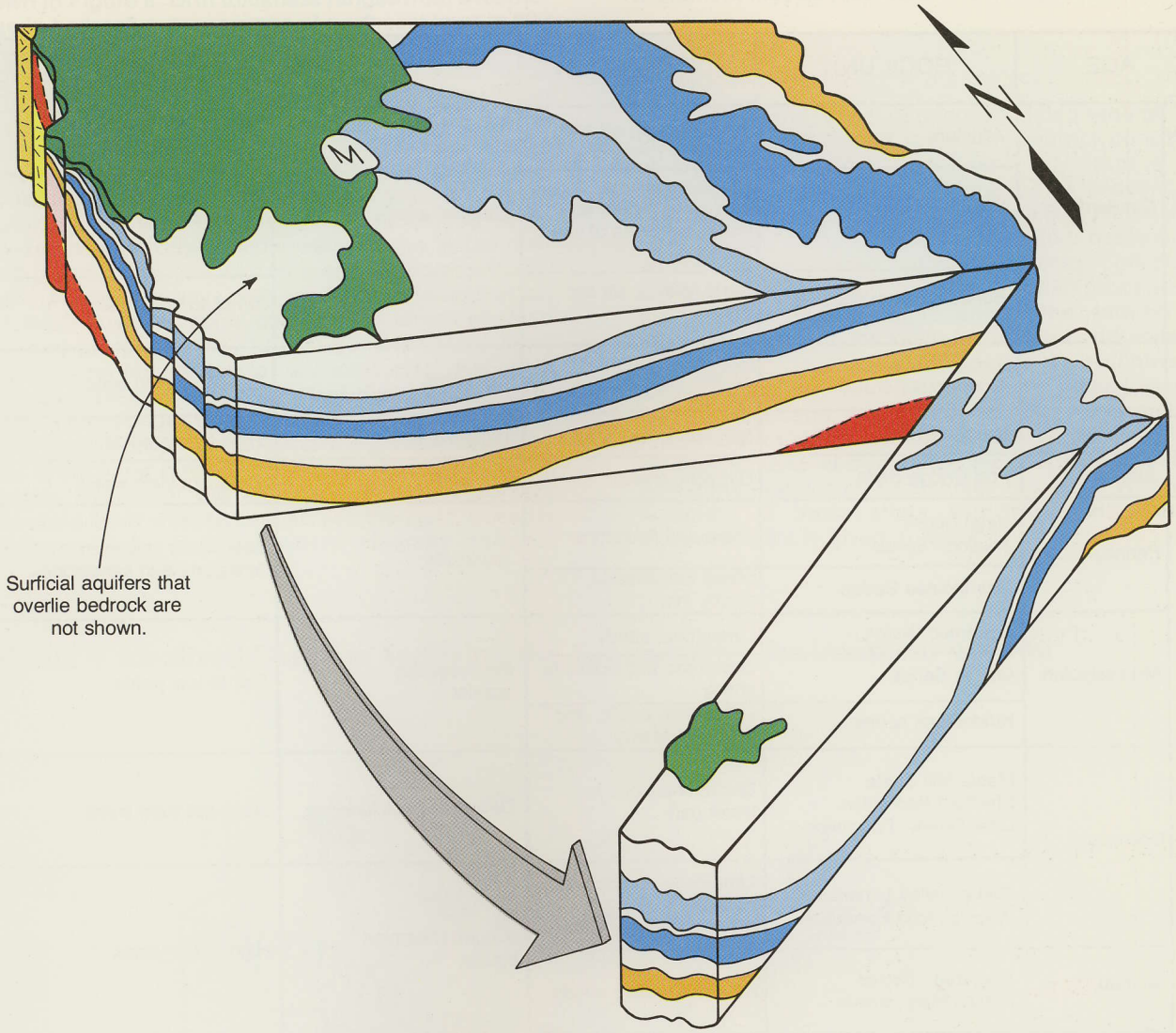


TABLE 1 Geologic and Hydrogeologic Units in Iowa

AGE		ROCK UNIT	DESCRIPTION	HYDROGEOLOGIC UNIT	WATER-BEARING CHARACTERISTICS
Cenozoic	Quarternary	Alluvium	Sand, gravel, silt and clay	Surficial aquifer	Fair to large yields
		Glacial drift (undifferentiated)	Predominantly till containing scattered irregular bodies of sand and gravel		Low yields
		Buried channel deposits	Sand, gravel, silt and clay		Small to large yields
Mesozoic	Cretaceous	Carlile Formation Granerous Formation	Shale	Aquiclude	Does not yield water
		Dakota Group	Sandstone and shale	Dakota aquifer	High to fair yields
	Jurassic	Fort Dodge Beds	Gypsum, shale	Aquitard	Does not yield water
Paleozoic	Pennsylvanian	Virgil Series Missouri Series	Shale and limestone	Aquiclude	Low yields only from limestone and sandstone
		Des Moines Series	Shale; sandstones, mostly thin		
	Mississippian	Meramec Series	Limestone, sandy	Mississippian aquifer	Fair to low yields
		Osage Series	Limestone and dolomite cherty		
		Kinderhook series	Limestone, oolitic, and dolomite, cherty		
	Devonian	Maple Mill Shale Sheffield Formation Lime Creek Formation	Shale; limestone in lower part	Devonian aquiclude	Does not yield water
		Cedar Valley Limestone Wapsipinicon Formation	Limestone and dolomite; contains evaporites in southern half of Iowa	Silurian-Devonian aquifer	High to fair yields
	Silurian	Niagaran Series Alexandrian Series	Dolomite, locally cherty		
	Ordovician	Maquoketa Formation	Shale and dolomite	Maquoketa aquiclude	Does not yield water, except locally in northwest Iowa
		Galena Formation	Limestone and dolomite	Minor aquifer	Low yields
		Decorah Formation Platteville Formation	Limestone and thin shales; includes sandstone in SE Iowa	Aquiclude	Generally does not yield water; fair yields locally in southeast Iowa
		St. Peter Sandstone	Sandstone	Cambrian-Ordovician aquifer	Fair yields
		Prairie du Chien Formation	Dolomite, sandy and cherty		High yields
	Cambrian	Jordan Sandstone	Sandstone		
		St. Lawrence Formation	Dolomite	Aquiclude (wedges out in northwest Iowa)	Does not yield water
		Franconia Sandstone	Sandstone and shale		
		Dresbach Group	Sandstone	Dresbach aquifer	High to low yields
Precambrian		Sioux Quartzite	Quartzite	Base of groundwater reservoir	Not known to yield water except at Manson cryptovolcanic area
		Undifferentiated	Coarse sandstones; crystalline rocks		

*Adapted from Steinhilber and Horick

FIGURE 10 Generalized Bedrock Section of Iowa



EXPLANATION

M

Manson Anomalous Area
Believed to be a cryptovolcanic structure (Hoppin and Dryden, 1958)

AQUIFERS

Cretaceous

Mississippian

Silurian-Devonian

Cambrian-Ordovician

Dresbach

Paleozoic

CONFINING BEDS

Sedimentary rocks

Precambrian crystalline rocks

Source: Modified from Steinhilber and Horick, 1970

If the overlying unconsolidated materials are removed (Figure 9), one would see the beveled edges of the bedrock formations appearing as broad northwest-southeast trending bands that decrease in geologic age from northeast toward the southwest (Figure 10). This pattern is created by a gentle regional downwarping of the layered rock toward a shallow basin centered near southwestern Iowa. In the northwest, the older (Paleozoic) sedimentary rocks are capped by much younger, nearly flat-lying sedimentary rocks of Cretaceous age that mask the banded pattern of the Paleozoic rocks.

Iowa Aquifers

The aquifers are divided into two general categories, **surficial aquifers** and **bedrock aquifers**. Surficial aquifers occur in the unconsolidated glacial and alluvial materials, principally sand and gravel. They are subdivided into the **glacial drift aquifers**, consisting of localized sand and gravel bodies within the glacial drift; the **alluvial aquifers**, associated with the flood plains of the major streams; and the **buried channel aquifers**, located in preglacial bedrock valleys hidden beneath the glacial drift. Bedrock aquifers are comprised of water bearing limestones and sandstones lying in several horizons beneath the state. Functioning together, these aquifer systems form a vast natural storage-distribution system for water.

The Surface Waters of Iowa

Streams

Iowa's streams supply water for human consumption, agriculture, industrial operations, cooling purposes, generation of hydroelectricity, recreation and other purposes, and they accept and assimilate effluents from water pollution control facilities. It is obvious that many of these uses are in confict and require the establishment of priorities and control.

Iowa's major drainage basins and River Basin Planning areas are identified in Figure 11. About 69 percent of Iowa drains into the Mississippi River while the remaining 31 percent lies within the Missouri River drainage basin. Streamflow has its origin in surface runoff from precipitation, and discharge from underground sources.

Average annual runoff of Iowa streams, prorated over the areas of the basins in depth of water in inches, is shown in Figure 12. The runoff pattern correlates with the average distribution of precipitation, with the most deficient areas of both precipitation (less than 28 inches) and runoff (less than 2 inches) occurring in northwest Iowa. Figure 13 shows graphically the average discharge of Iowa's principal rivers.

FIGURE 11 Iowa Conservancy Districts

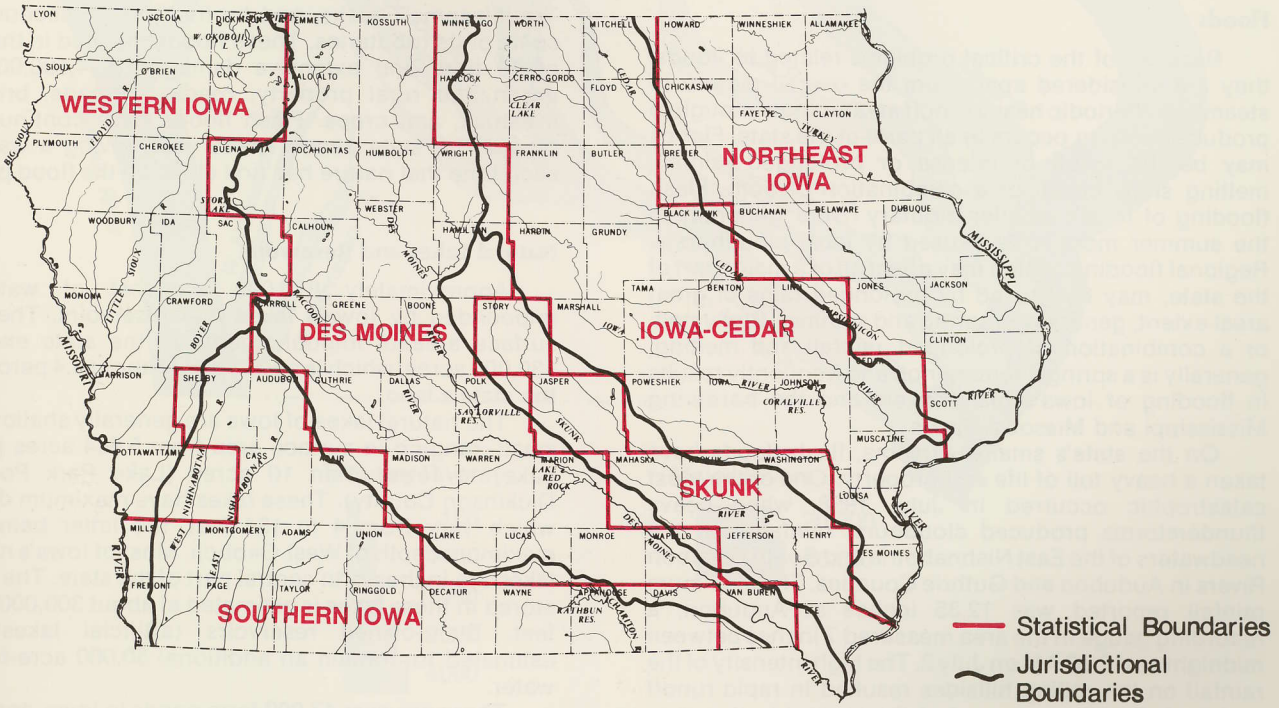
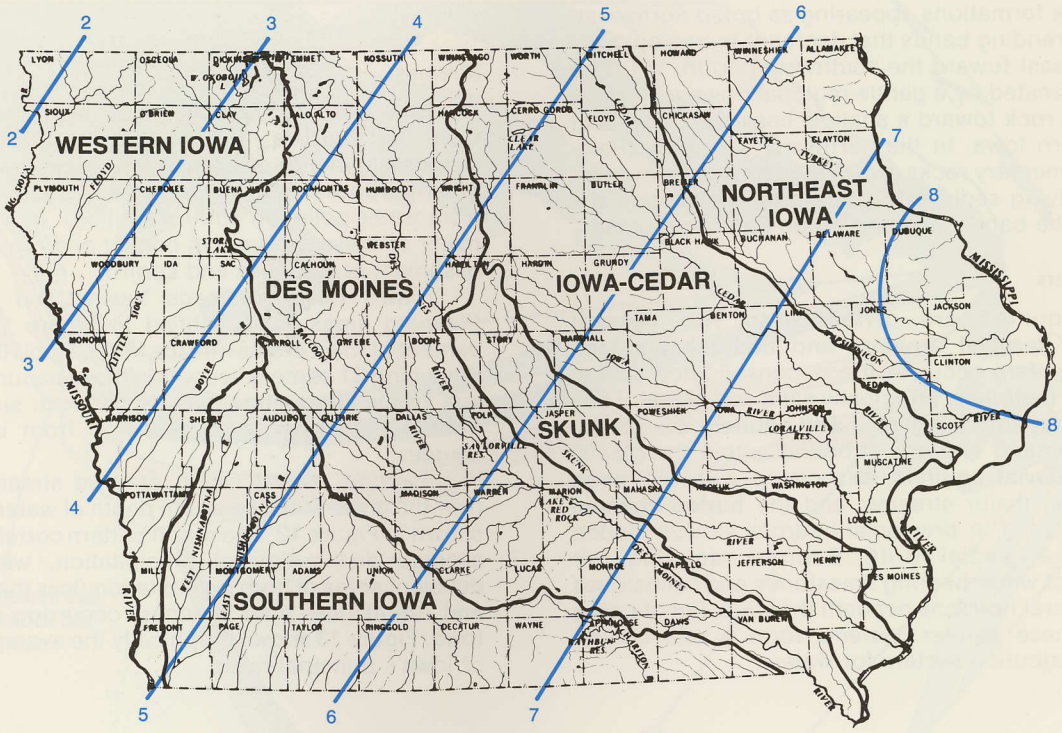


FIGURE 12 River Basin Districts and Average Annual Runoff



Floods

Because of the critical problems related to floods, they are considered apart from the overall picture of steamflow. Periodic heavy runoff at rates high enough to produce flooding occurs in all parts of the state. Floods may be the result of intense or prolonged rainfall, melting snow cover, or a combination of both. Flash flooding of Iowa's smaller tributary rivers, generally in the summer months, is caused by local cloudbursts. Regional flooding, which may affect all or a major part of the state, may be caused by prolonged rains of great areal extent, generally in spring and summer. Snowmelt, or a combination of prolonged rainfall and melting, generally is a spring phenomenon and frequently results in flooding of Iowa's major rivers and the bordering Mississippi and Missouri Rivers.

On the state's smaller streams, flash floods have taken a heavy toll of life and property. One of the most catastrophic occurred in July, 1958, when heavy thunderstorms produced cloudburst rainfall over the headwaters of the East Nishnabotna and South Raccoon Rivers in Audubon and Guthrie Counties. The maximum rainfall reported was 12.35 inches at Audubon; a recording gauge in the area measured 7 inches between midnight and 2:30 AM on July 2. The high intensity of the rainfall on the rolling hillsides resulted in rapid runoff and flash flooding on most of the steams in the area. Major damages were caused by the East Nishnabotna and its tributaries, especially Blue Grass, David's, and Troublesome Creeks, and by the South Raccoon and some of its tributaries. These floods resulted in the loss of 19 lives and extensive damages ($14,500,000) to urban and rural property, roads, railroads, bridges, livestock, and crops. Flash floods have continued to plague the state almost every year, giving a warning each time that nature has first claim on the flood plains.

Natural Lakes and Reservoirs

Approximately 870,000 acre-feet of water is impounded by Iowa's lakes and reservoirs. The total surface area of impoundments in the state exceeds 130,000 acres, which is equal to only about 0.4 percent of the state's land.

The natural lakes of Iowa are generally shallow and small, ranging in surface area from 5,684 acres (Spirit Lake) to fewer than 10 acres (Lake Park Pond in Dickinson County). These lakes have maximum depths which vary from 4 to 134 feet, the latter being the maximum depth of West Okoboji. Most of Iowa's natural lakes are in the north central part of the state. The water stored in these lakes is estimated at about 300,000 acre-feet. State-owned reservoirs (artificial lakes) are estimated to contain an additional 50,000 acre-feet of water.

There are over 47,000 farm ponds in Iowa, and their total storage capacity exceeds 119,000 acre-feet. Most of these are located in the southern half of the state

where surface water is limited during dry summer months and groundwater is sometimes chemically unsuitable or too deep to develop economically.

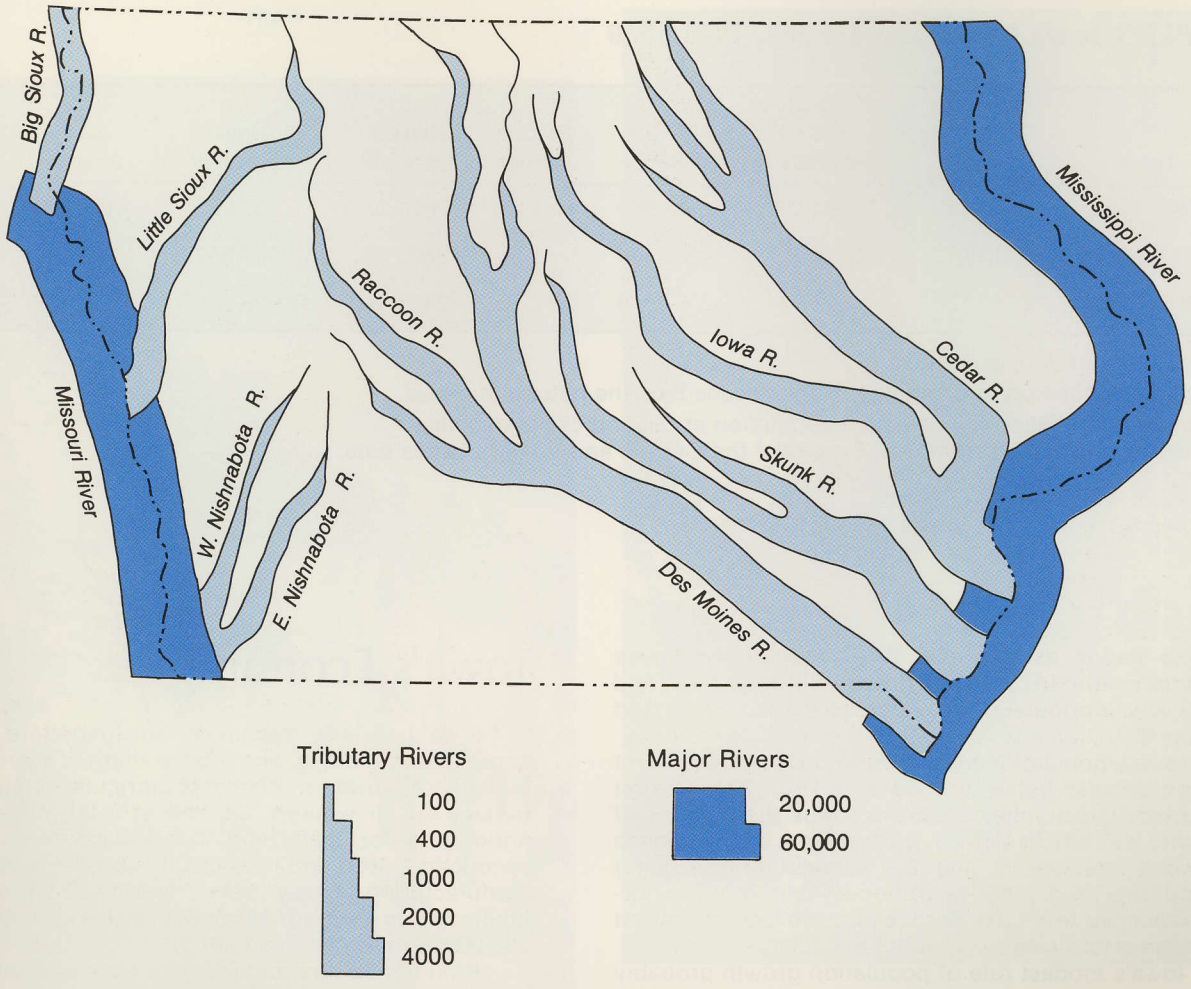
There are four U.S. Army Corps of Engineers multiple purpose reservoirs in Iowa: Coralville, Redrock, Rathburn, and Saylorville. At normal pool level, these reservoirs have a total combined storage capacity of about 400,000 acre-feet.

The People

Knowledge about the size, composition, and distribution of population in the future is essential to planning for economic and social development. It is only when the future demands for goods, services, and facilities are known that these demands can be met and dealt with in an orderly and adequate manner. Future demands of a population depend upon the size and characteristics of that population—the number of total population, the number of young, old, and working people, etc. Whether planning for water resource management or for schools, churches, medical service, transportation, utility, welfare or business, population projections will provide a rough guide for estimating future needs.

Today, Iowa has more than 2.8 million people and ranks 25th in population among the states of the nation. Although the growth rate has been steady, the population of the state has not grown as rapidly as that

FIGURE 13 Average Discharge of the Principal Rivers



Width of river indicates average discharge in cubic feet per second.

Source: U.S.G.S. Surface Water Division, Iowa

TABLE 2 United States and Iowa Population Trends, 1900-1970

Census Year	Population Totals		Percentage Change		Iowa's Rank Among States
	United States	Iowa	United States	Iowa	
1900	75,994,575	2,231,853	—	—	10
1910	91,972,266	2,224,771	+21.0	-0.3	15
1920	105,710,620	2,404,021	+14.9	+8.1	16
1930	122,775,046	2,470,939	+16.9	+2.8	19
1940	131,669,275	2,538,268	+ 7.2	+2.7	20
1950	150,697,361	2,621,073	+14.5	+3.3	22
1960	179,323,175	2,757,537	+19.0	+5.2	24
1970	203,184,772	2,825,041	+13.3	+2.4	25

Source: U.S. Bureau of the Census

TABLE 3 Iowa Migration Trends, 1940-1970

Years	Beginning of Decade	Population end of Decade	Actual Change	Percent Change	Natural Increase[1]	Potential Population[2]	Net Change[3]	Percent Net Migration
1940-1950	2,538,268	2,621,073	82,805	+3.3	265,317	2,803,585	-182,512	-7.2
1950-1960	2,621,073	2,757,537	136,464	+5.2	372,779	2,993,852	-236,315	-9.0
1960-1970	2,757,537	2,825,041	67,504	+2.5	247,544	3,005,081	-180,040	-6.5

[1]Excess of births over deaths.

[2]Total of population at beginning of the decade plus the natural increase.

[3]Potential population minus actual population at the end of the decade.

Sources: Computed from U.S. Bureau of the Census and Vital Statistics data.

of the nation as a whole. While the United States experienced a 167 percent growth between 1900 and 1970, Iowa's population only increased about 27 percent (Table 2).

Iowa's population increased 67,500, or 2.4 percent in the decade between 1960 and 1970. The natural increase (the number of births minus the number of deaths) was 247,544 in the same period; the difference between the natural and the actual increase being accounted for by out-migration (Table 3). The out-migration in this past decade has slowed somewhat compared to the two preceding decades.

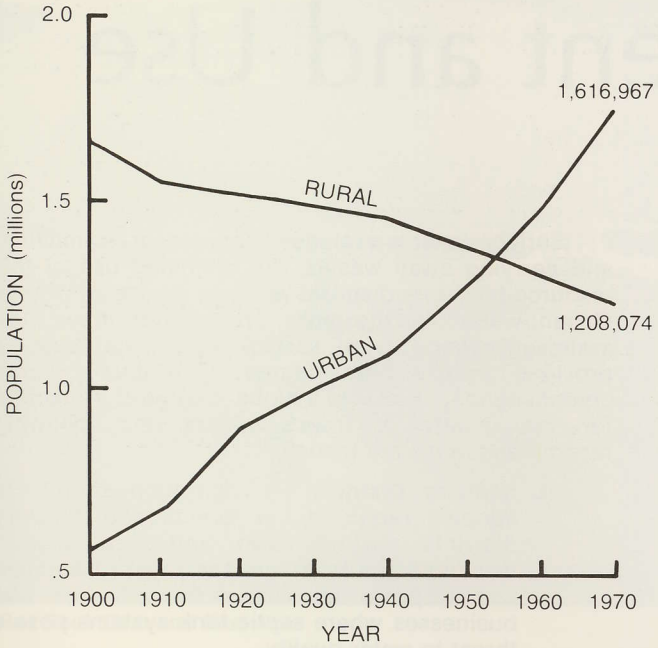
Iowa's modest rate of population growth probably will hold for the next several decades, a factor that will aid in the orderly development of the state's land and water resources.

Iowa's Economy

Iowa has long depended on agriculture for her economic well-being, and a large share of the non-farm industry of Iowa is related to agriculture. Nearly 80 percent of all workers depend at least indirectly on agriculture for their jobs in chemical and fertilizer production, seed and livestock businesses, or machine manufacturing. Today, nearly one million Iowans are employed in non-agricultural pursuits, compared to 250,000 working on Iowa farms.

Both agriculture and industry have vital interest in water resource availability, water quality, and water use policies such as pollution control and flood plain management.

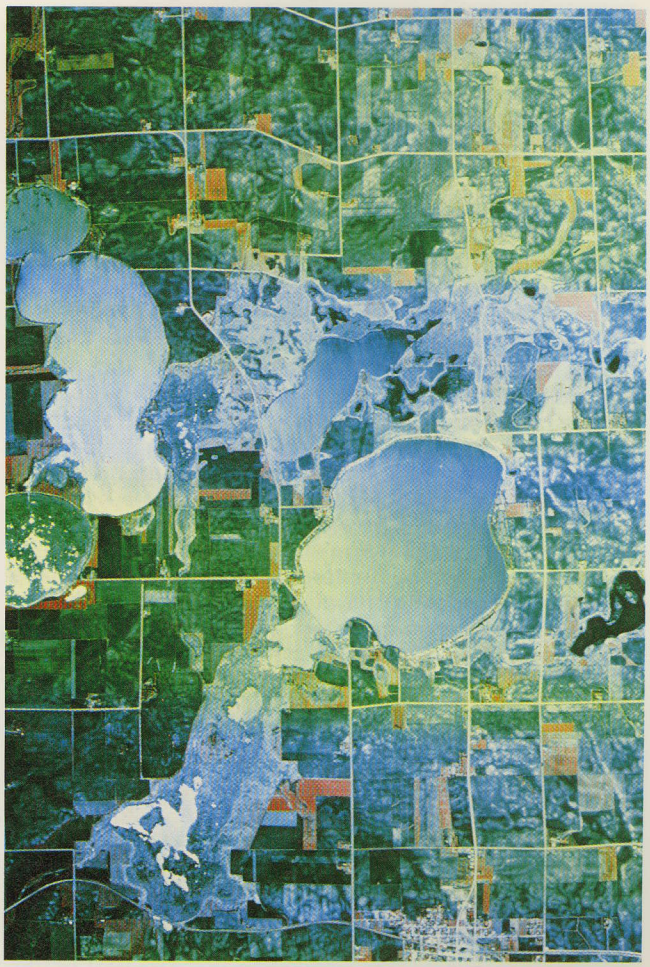
FIGURE 14 Rural and Urban Population Trends in Iowa (1900-1970)



Quality of Life and Environment

Iowa is viewed by many as a land of clean air and water, unspoiled by modern industrial society. Although Iowa does not face the severe pollution problems of more densely settled and highly industrialized states, its population growth, intensive agriculture, and industrialization have had adverse environmental impacts. Most Iowa streams now have some degree of pollution, air pollution plagues our urban areas, and soil erosion and indiscriminate urban sprawl have scarred the landscape. A carefully formulated plan for future development of Iowa's water resources must address itself to reversing some of these undesirable trends, while maintaining a level of growth and development commensurate with a high quality of life.

Upper Iowa River near Bluffton, Winneshiek County
K. Formanek



Trumbull and Lost Island Lakes—natural morainal lakes on the Des Moines Lobe
NASA

3 Problems of Development and Use

Water Resource Availability

Water resource planning requires a detailed knowledge of all aspects of the climatology, hydrology, and geology of the state. Evaluation of major sources of water are basic because of the complex nature and regional diversity of water resources, particularly of groundwater sources. To obtain a better concept of the state's water resource base, it is recommended that the following research programs be implemented:

1. **Data on Water Availability** — The acquisition of water availability data, which is critical to the implementation of the state's water quality and water withdrawal regulatory programs, must be expanded if the goals of these programs are to be achieved. The state should place a high priority on obtaining the needed water data. The Iowa Water Resources Data System (IWRDS), being prepared by the Iowa Geological Survey, attempts to provide greater coordination of state water data collection and should be further developed.
2. **Groundwater Studies** — Special studies of the hydrological characteristics of certain aquifers that are experiencing heavy pumpage pressures are urgently needed to ensure that the aquifer's water storage capabilities are not being permanently destroyed.

Water Quality

There is no such thing as "pure" water in nature. Its quality is affected by numerous natural and man-made factors. The quality of water cannot be measured in isolation; only when the intended use is considered can water quality be evaluated.

Water quality varies greatly across Iowa. Groundwater in several areas is unsuitable for many uses because of naturally occurring high concentrations of nitrates and dissolved solids. Surface waters are naturally contaminated by sediments and nutrients contained in surface runoff; however, humans have greatly accelerated this process by current land use practices. To this natural contamination has been added toxic chemicals and organic wastes from municipal and industrial waste treatment plants and livestock feeding operations. The decomposing organic wastes can deplete the dissolved oxygen in the streams to the detriment of fish. Heat from electrical generation or other industrial cooling processes may adversely affect the aquatic habitat.

Surface water is a valuable resource for assimilating and carrying away wastes, but unlimited use of this resource for waste disposal will limit its use by others. Groundwater, furthermore, does not have the assimilative capacity of surface water and must be provided with a high degree of protection from contamination. To assure a higher degree of protection for the quality of Iowa's waters, the following recommendations are made:

1. **Sanitary Districts** — Legislation should be adopted requiring the formation of sanitary districts around lakes and rural cluster developments to assure the proper treatment and disposal of wastes from homes and businesses where septic tank systems pose a threat to water quality.
2. **Boat Sanitary Facilities** — Sanitary facilities for boats and recreational areas must be required to protect public health and water quality.
3. **Nonpoint Source Pollution** — State controls are needed to solve serious rural and urban nonpoint source pollution problems. Existing soil conservation programs and nonpoint controls proposed by the Section 208 water planning program should be given the highest funding priority, and implementation of the controls should initially be focused on waters having the highest value to the state.
4. **Groundwater Protection** — All phases of well construction and operation must be regulated to prevent groundwater pollution. Well drillers and pump installers must be licensed and minimum construction and abandonment standards enforced.
5. **Solid Waste Disposal** — The Department of Environmental Quality's authority to regulate solid waste disposal should be extended to include disposal of industrial waste on land owned or leased by the industry.

Water Supply and Use

In 1975, it is estimated that over 1.3 trillion gallons (3,990,000 acre-feet) were withdrawn from groundwater and streams in Iowa for various uses. This amount is equal to a withdrawal rate of 3.6 billion gallons per day (bgd), or 1,400 gallons per day per person. An estimated 460 million gallons per day (mgd) of that use were considered consumptive, meaning the water is no longer available because it has been either evaporated,

Red Rock Dam and Reservoir *Corps of Engineers*

transpired, incorporated into products consumed by living beings, or otherwise removed from the immediate environment.

For Water Plan '78, water use was broken down into three major categories: those uses served by public water systems, agricultural uses, and industrial uses (Figure 15).

Public Water Systems

It is estimated that currently 73 percent of the population of Iowa is served by public systems, both municipal and rural; of these, 73 percent are dependent on groundwater sources. Per capita use on public systems has increased from 106 gpd in 1960, to 145 gpd in 1975 (Table 4).

Industrial Uses

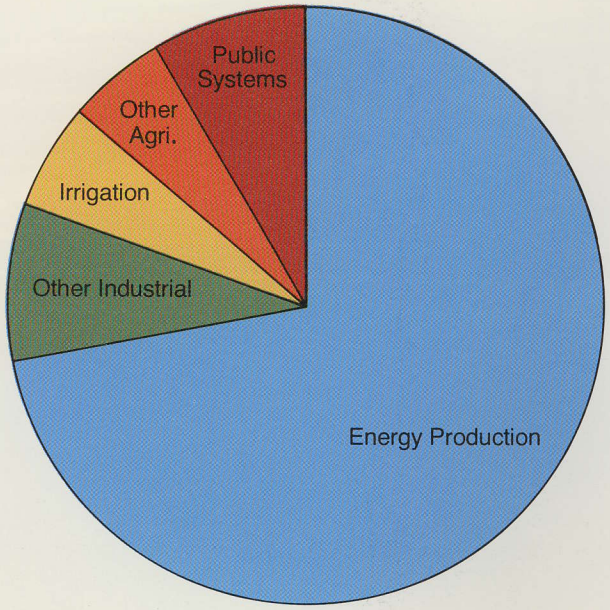
Industrial water uses are placed in two categories in the framework study: water for power generation and water for manufacturing and processing. As graphically demonstrated in Figure 15, water for energy production far exceeds any other withdrawals within the state. However, the consumptive use is less than for other major user groups. A look at the estimated use in the year 2020, however, indicates that in addition to the great increase in demand for water in energy production, both in total quantity and percentage of total use, the consumptive use increases dramatically (Figure 16). By 2020, consumptive use for energy production exceeds even that for irrigation, the result of increased re-use of water for cooling that increases the loss of water through evaporation. Further consideration and recommendations are discussed in the following section on Water for Energy Production.

TABLE 4 Estimated Water Use in Iowa, Water Used for Public Supplies*

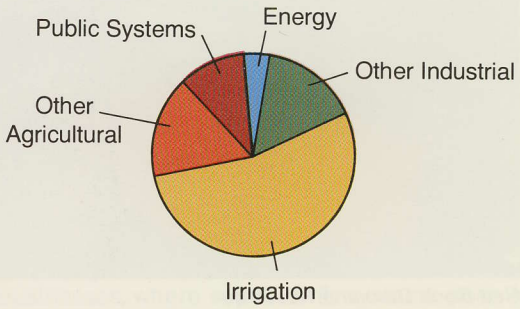
Year	Water Withdrawn (MGD)				Water Delivered (MGD)				Water Consumed (MGD)
	Ground Water	Surface Water	All Water	Per Capita (gpcd)	Industrial & Commercial Use			Domestic Use & Loss	
					Air Cond.	Other	All Uses		
1960	91	68	160	106	5.1	67	72	88	16
1965	150	47	200	104	1.2	56	57	140	19
1970	180	73	250	123	NA	NA	60	190	37
1975	216	80	296	145	NA	NA	86	210	45

*Based on estimates made by the U.S.G.S.
NA - Not available.

FIGURE 15 Water Withdrawals and Consumption by Use Categories, 1975

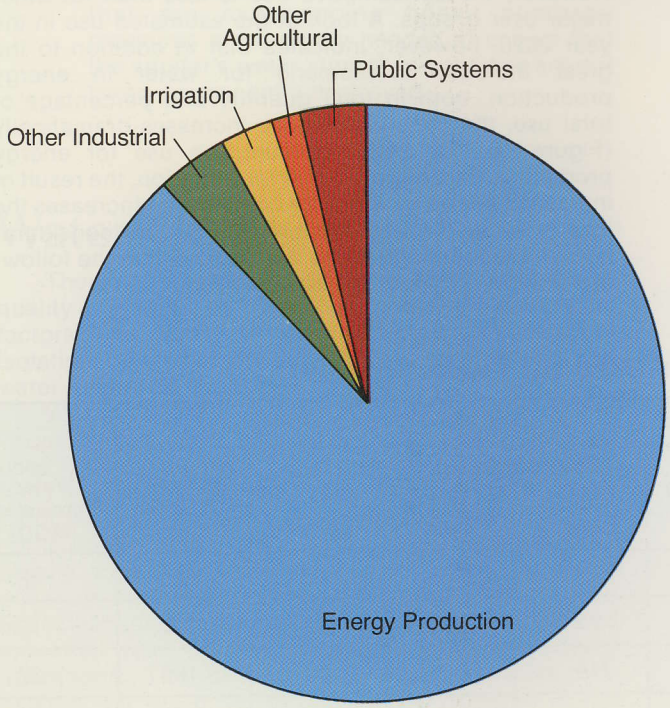


WATER WITHDRAWALS 1975
(3,678 mgd)

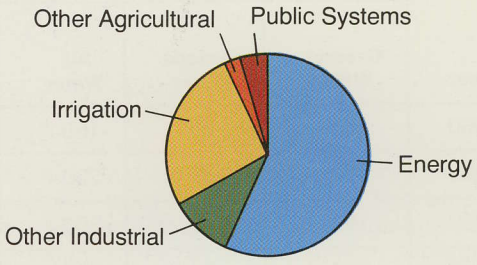


COMSUMPTIVE USE 1975
(393 mgd)

FIGURE 16 Estimated Water Withdrawals and Consumptive Use, 2020



ESTIMATED WATER WITHDRAWALS 2020
(27,531 mgd)



ESTIMATED CONSUMPTIVE USE 2020
(2,886 mgd)

Agricultural Water Use

There are three categories of agricultural water use—self-supplied domestic, livestock, and irrigation. Irrigation is by far the largest of these, and is almost 100 percent consumptive; that is, none of the water withdrawn is returned to Iowa streams. Although withdrawals for irrigation ranks behind industrial and public system withdrawals, it is by far the major consumptive user (Figure 16).

Recommendations

Selected recommendations from the framework study follow:

1. **Priority of Use** — The state's water permit system should be expanded to cover large volume water uses that are presently unregulated; water withdrawals subject to the system should be allocated by means of administratively set priorities that are based on the nature of the beneficial use of the water and the adequacy of supply from the source for the withdrawal.
2. **Restriction on Groundwater Use** — Limited groundwater supplies in certain areas of the state (primarily in the south central and western portions of the state) mandate greater use of surface storage if water dependent economic growth is to occur. Large volume industrial and municipal users of groundwater will have to be subject to well-spacing and groundwater drawdown restrictions. No increases in power generation water uses or other comparably heavy industrial water use can be allowed from groundwater sources other than border stream alluvial aquifers, and there only after careful evaluation of the impact on water supply and protection flows.
3. **Natural Lakes** — Iowa's natural lakes must be protected: no new allocation of water for consumptive uses from these lakes should be allowed, and current users of natural lake water should not be permitted to make any substantial increases from the present withdrawal rate.
4. **Water Supply from Federal Reservoirs** — The state of Iowa should establish a goal to achieve optimum development of water supply capability in all federal reservoirs. The state should encourage and insist that the Federal Government give water supply storage an equal status to flood control, recreational development, and other beneficial uses, with a corresponding cost allocation equalization.
5. **Rural Water Districts** — Development of rural water distribution systems should be conditioned on securing an adequate and reliable supply source and on limiting use of the system's water to domestic and livestock watering needs that will not encourage urban sprawl.

Irrigating crops with center pivot equipment *Valmont Industries*

Mississippi River Flood at Davenport, May 1965 *Corps of Engineers*

Flood Plain Management

The concept of flood plain management is based on a public policy that seeks to minimize flood damages by encouraging flood plain uses that are compatible with that goal. Flood plain occupancy for purposes other than agriculture, woodlands, open space, recreation, and fish and wildlife habitat is extremely poor land use. Experience has shown that the loss of life and property from floods far outweighs the economic benefits from more intensive uses. Only eight percent of the total land area of the state is in flood plains, but there is an inordinate amount of pressure to develop them for less compatible industrial, commercial, transportation, and residential uses.

The Code of Iowa defines a flood plain as "the area adjoining the river or stream which has been or may be hereafter covered by flood water." In many valleys with steep side slopes, the flood plain may extend from bluff to bluff.

There are flood plain management programs at both the federal and state levels. Federal efforts include: (1) the U.S. Department of Agriculture's watershed program for soil and water conservation and flood prevention, (2) the Corps of Engineer's flood control projects and other flood-related programs, (3) the U.S. Geological Survey's stream data collection program, (4) the National Flood Insurance Program administered by the Federal Insurance Administration, and (5) the disaster assistance program of the Federal Disaster Assistance Administration.

The state flood plain management program has been carried out primarily by the Iowa Natural Resources Council. The Council reviews proposals relating to flood control and water resources development by federal agencies. This includes coordination of flood plain information studies, usually conducted by the U.S. Army Corps of Engineers and flood insurance programs of the Federal Emergency Management Administration. The Council is also charged with flood plain regulation as it relates to any development and construction in the flood plain. All construction projects in flood plains are reviewed by the staff and the Council and must meet its criteria.

The Council currently regulates any construction, escavation, etc., in the 100-year flood plain (See Figure 17), and prohibits any construction in the 100-year flood way (that area needed to convey the floodwater at a 100-year flood discharge). Almost all state or federal flood plain management programs rely on this 100-year flood criterion which basically means that, statistically, in any given year there is a one percent chance of exceeding a flow of that magnitude.

Mississippi River flood at Sabula, 1965

Iowa Natural Resources Council

Rural flooding, Mississippi River, 1965

Iowa Natural Resources Council

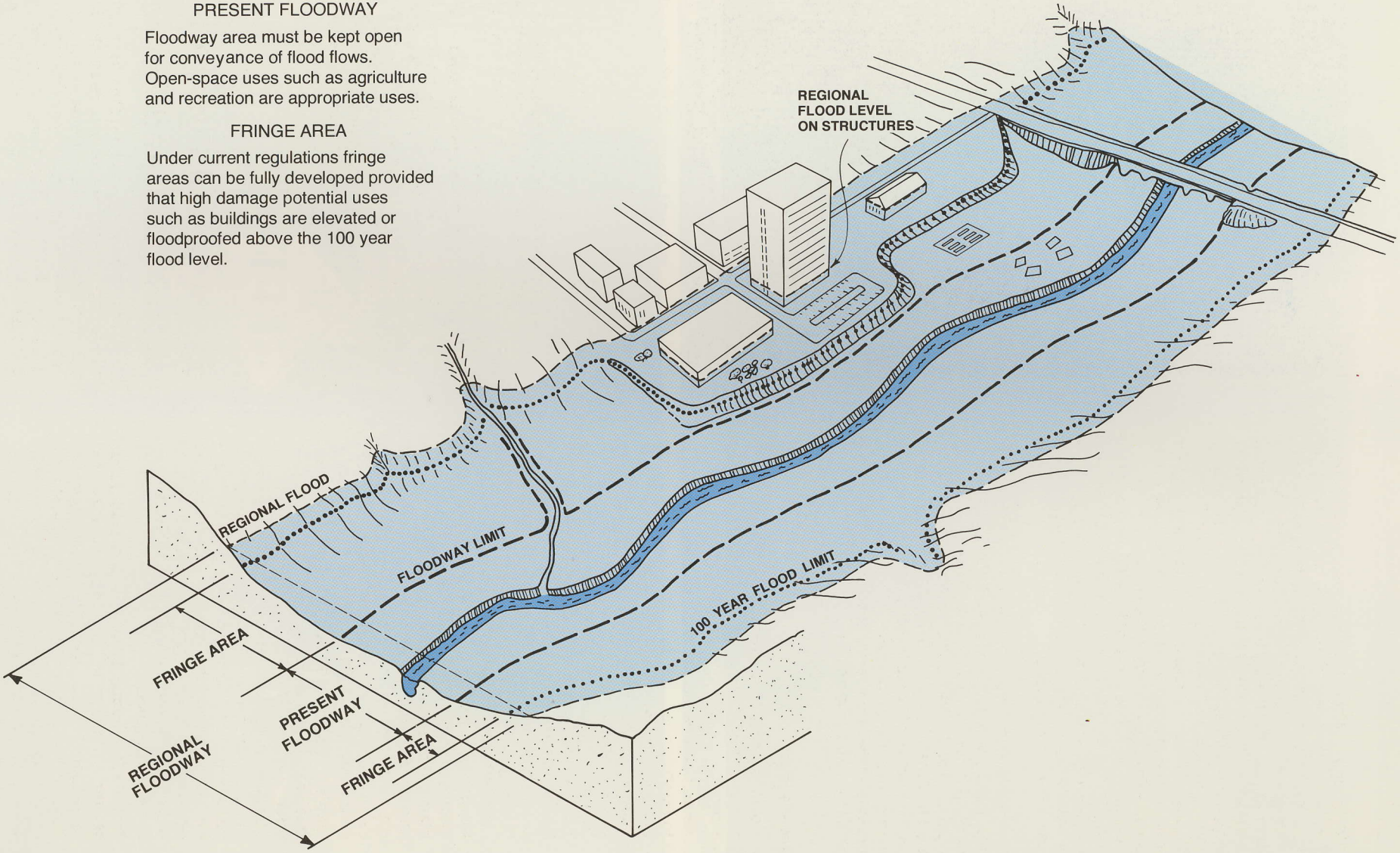
FIGURE 17 Floodway, Floodway Fringe, and Regional Flood Concept

PRESENT FLOODWAY

Floodway area must be kept open for conveyance of flood flows. Open-space uses such as agriculture and recreation are appropriate uses.

FRINGE AREA

Under current regulations fringe areas can be fully developed provided that high damage potential uses such as buildings are elevated or floodproofed above the 100 year flood level.



Unfortunately, while the 100-year flood statistic gives the public a sense of security, nature does not always follow probability curves. Iowa is sufficiently large, compared to the area covered by severe local thunderstorm activity, that almost every year some area of the state experiences a flood having a 100-year to 500-year frequency. Rainfalls of up to 12 inches in 6 hours or less, and 16 inches in 24 hours, have caused most of these floods. This is the real concern in evaluating the flash flood potential and hazard to human activities in the many small tributaries in urban areas.

At present, only nine areas of the state participate in the Flash Flood Warning Network of the U.S. National Weather Service. Many other areas of the state have serious potential for dangerous flash flooding. In some instances, the communities are unaware that the threat exists.

The Iowa Natural Resources Council has proposed a regional flood plain be established to replace the 100-year flood plain for controlling flood plain occupancy. The regional flood plain is the area that would be inundated by the INRC regional flood, defined as a large flood representative of floods which have been observed on streams and rivers of Iowa. The regional flood excludes extremely rare events, but it would exceed the 100-year magnitude (Figure 17).

Recommendations

The Iowa Natural Resources Council makes the following recommendations to facilitate improved flood plain management in Iowa:

1. **Flood Plain Properties Use and Sale** — In order to better protect life and property from severe flooding, it is recommended that legislation be adopted to: A. Restrict all new construction for human occupancy in the INRC designated Regional Flood Plain; B. Require that the sale of all properties in the INRC Regional Flood Plain be conditioned on official notice that said property is in the flood plain and subject to flooding; C. Provide tax incentives for owners to maintain the flood plain in its natural state.
2. **Flood Plain Zoning** — Legislation should be adopted requiring mandatory adoption of flood plain management ordinances by all counties and by cities with flooding problems. This flood plain management program would include land use cntrol, zoning, subdivision regulation, etc. on any land in the INRC Regional Flood Plain.
3. **Limited Use of Structural Flood Control Devices** — All nonstructural alternatives to flood control should be explored prior to consideration of structural measures. Approval of all structural measures should be conditioned on a stringent flood plain zoning in the locality of the project. Adverse and beneficial effects of any proposed structural project on the total river system will have to be carefully weighed.
4. **Flood Plain Acquisitions** — Flood plain lands should carry the highest priority for recreational land acquisition. Multipurpose acquisition of flood plain land should be considered as an alternative to any major structural flood control project.

Stream meandering in straightened channel
Iowa Geological Survey

5. **Storm Water Management** — Major urban areas should be required to incorporate storm water management and retention concepts in their zoning regulations.
6. **Flash Flood Warning Network** — A concerted effort must be made to incorporate into the Flash Flood Warning Network every major flash flood prone urban area, or any other area where lack of warning would create serious hazards to life and property. Additional coordination with the National Weather Service is recommended.

Fish and Wildlife and Water-Oriented Recreation

Water is a focal point for recreation such as boating, swimming, and fishing, or as a aesthetic backdrop for other outdoor activities. Demand for water-oriented recreation is expected to increase steadily in the coming decades, with Iowans spending more time in recreation because of increased urbanization, a shorter work week,

Fishing on Spirit Lake *K. Formanek*

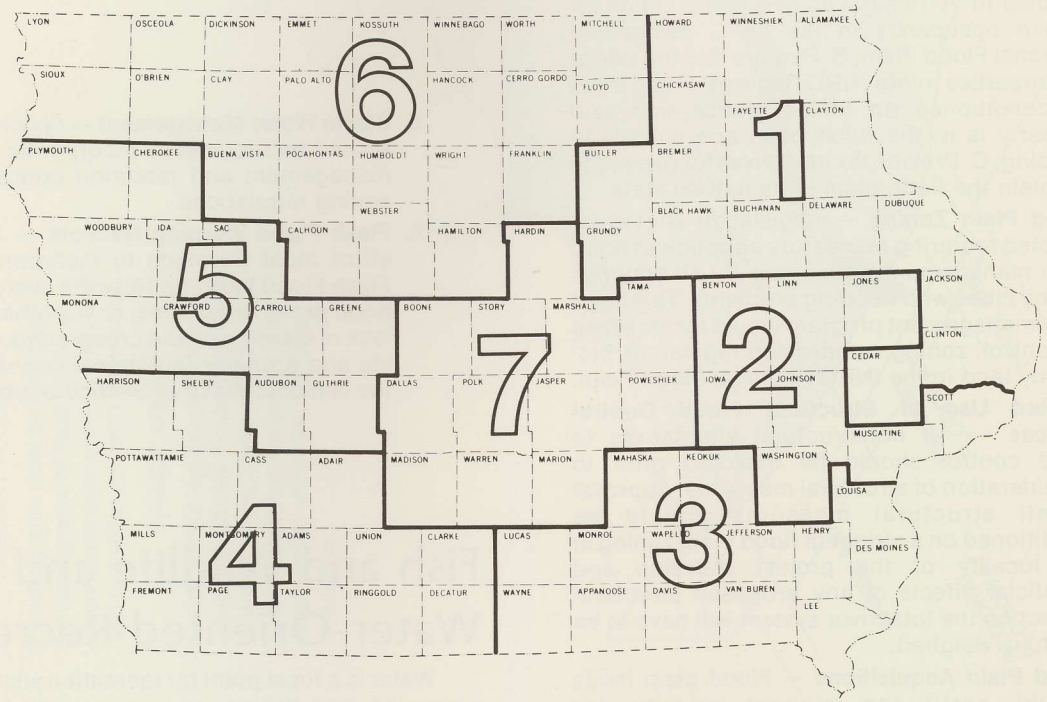
more discretionary income, and increased mobility. Unfortunately, the provision of additional water-oriented outdoor recreation has not kept pace with growing demands.

Critical recreational resources such as river and stream corridors, lake areas (natural and artificial), and wetlands, are in short supply in Iowa. Furthermore, they are constantly being diminished by encroachments such as vegetation clearing along lake shores and within river corridors, stream channelization, and wetland drainage.

Iowa's remaining water resources provide a major portion of the valuable open space, recreational opportunities, and fish and wildlife habitat currently remaining within the state. Also, the most significant areas of natural scenic beauty are associated with these resources.

The Iowa Conservation Commission has divided the state into seven Outdoor Recreation Regions (Figure 18), and has established priorities for development of water-related recreational resources for these regions. Priorities are summarized in Table 5; a high priority means that the region is particularly deficient in facilities for that particular activity.

FIGURE 18 Outdoor Recreation Regions



Recommendations

Recommendations pertaining to fish and wildlife and water-oriented recreation selected from the Framework Study are:

1. **Protected Water Area Program** — The state should fund and implement through the State Conservation Commission a "protected water area" program. The first step in establishing the program is an inventory of stream corridors, lake shorelines, and wetlands. Management powers needed include the authority to acquire scenic easements, by condemnation if necessary, and the authority to zone protected water areas by local jurisdictions or by the Conservation Commission if a local jurisdiction fails to act. As an important component of the program, the Conservation Commission should develop a "scenic river system" designed to protect the shorelines of the rivers offering the best recreational opportunities and to ensure greater public access to these rivers.
2. **Stream Use Rights** — The public's right to use the flow and bed of the state's streams for recreational purposes should be delineated by legislation.
3. **Flat-Water Recreational Deficiencies** — Flat-water recreational areas should be constructed in those portions of the state where shortages exist, such as Waterloo, Sioux City, and Council Bluffs.

TABLE 5 Regional Recreational Priorities

Region	Water Dependent Activities			Water Enhanced Activities		Statewide Priority for Water Dependent Activities
	Boating	Fishing	N.E. Swimming	Picnicking	Camping	
1	L	L	L	M	L	Low
2	H	M	H	M	H	High
3	L	L	M	M	H	Low
4	L	L	M	L	L	Low
5	H	H	M	L	M	High
6	H	M	L	L	M	Med.
7	M	H	H	H	M	High

Region	Each Region's Highest Priority for Water Dependent Activities
1	Boating (acreage)[1]
2	Swimming
3	Swimming
4	Swimming
5	Fishing
6	Boating (access)[2]
7	Fishing and Swimming

[1] Region 1 needs more water surface acreage close to its urban center to meet additional demands.

[2] Region 6 has an abundant supply of natural lakes but needs more public access sights to meet additional demands.

4. **Boat Operator Controls** —The state should establish a boat operator training and licensing program to improve boating safety.
5. **Missouri River Degradation** — The U.S. Army Corps of Engineers' river stabilization and navigation project of the Missouri River has increased riverbed scouring and currents to such an extent that water levels in adjacent lakes, streams, and alluvial aquifers have been lowered by as much as six feet. The net result of this degradation has been the draining and destruction of wet lands, loss of wildlife, interference with water supplies, and the creation of hazardous recreational boating conditions. The state should insist on immediate remedial action by the Corps of Engineers and not accept proposals for studies that would only delay the remedial action. The state should be compensated for irreversible losses to its natural resources by this project.

Water for Energy Production

Energy production is one of the many competing uses for water. Withdrawals of water for condenser cooling in thermal-electric plants are by far the largest use of water in the energy industry. Water is used in mining and reclamation of mined lands, processing and refining of fuels, conversion of solid fuel into gaseous or liquid state, disposal of waste products, and in other aspects of energy production. Water also is the prime mover in hydroelectric plants.

Iowa is not in a region where water supplies are expected to be critically short; however, there will still be water resource problems and conflicts involved with meeting the total water needs of the expanding energy industry and other beneficial users. This is particularly true for the interior portions of the state.

Coal

Development of Iowa's coal resources could have a significant impact on the state's water resources. Relatively small amounts of water are consumed in mining operations, but larger quantities are required to remove sulfur and other impurities from Iowa coal if it is to meet environmental quality standards. Coal gasification is a promising energy source to replace dwindling natural gas and petroleum supplies; however, it could place severe strains on water supplies, particularly in the coal producing areas of the state where water supplies are limited. Additionally, mining may have an adverse effect on water quality in streams because of acid water runoff from mining sites.

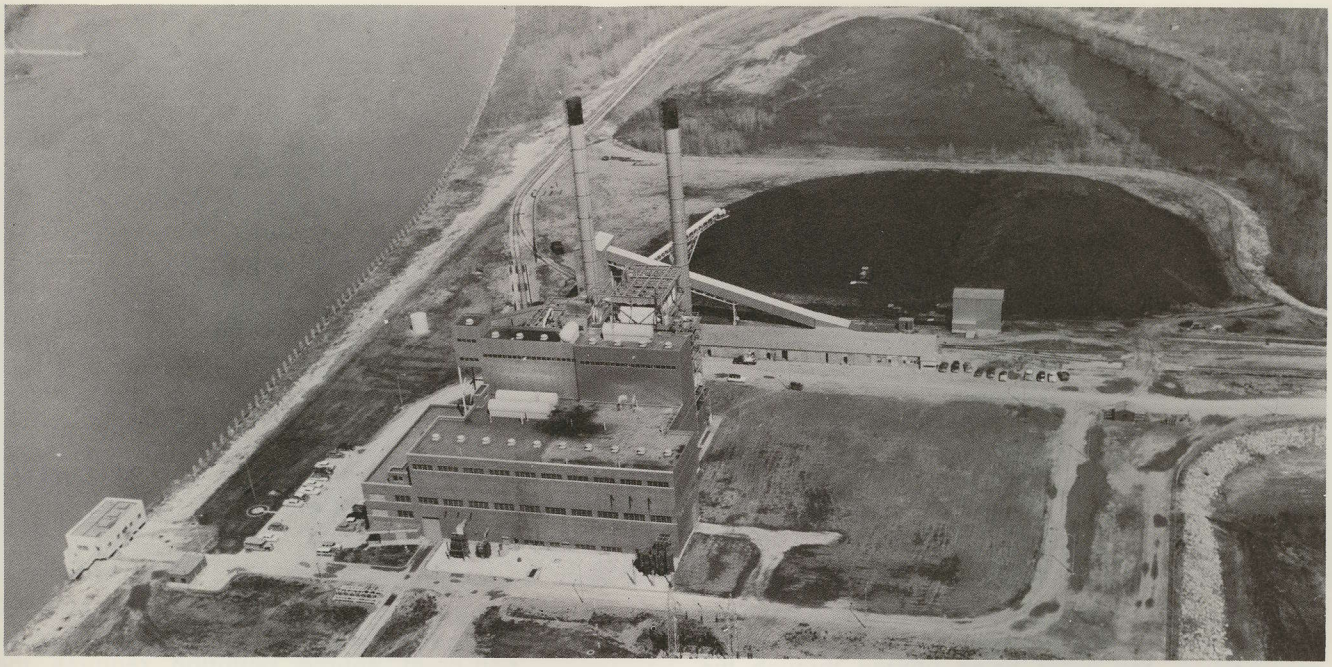
Electricity

The ever-increasing need for electricity places a heavy demand on the water resources of the state. Most of the present demand is met by steam-electric generating plants, with hydroelectric plants playing a very minor role. The water requirement for cooling the condensers of the steam-electric plants constitutes the largest gross demand for water in Iowa and the nation, except for the natural transpiration of water by growing crops and other vegetation.

The use of water for cooling in electrical generation, fortunately, is largely non-consumptive; that is, little water is lost by evaporation. Once-through cooling systems lose from one to two percent of the water used. However, once-through cooling is practical only on the border rivers where stream volume is sufficient to dilute the hot water of the return flows. Closed-cycle systems will be required at future generating plants on Iowa's interior streams. These systems require less total water intake than the once-through systems, but consumptive use is greater, requiring from two to four percent of the

Hydroelectric power plant and dam, Ottumwa

City of Ottumwa



Coal fired generating plant on Missouri River near Council Bluffs *Council Bluffs Chamber of Commerce*

gross condenser cooling requirement as "make-up" water to replace evaporation losses and to dilute mineral buildup. These requirements will place stresses on the natural stream flows during drought periods at those sites on interior Iowa streams.

Recommendations

The following recommendations concerning energy production are abstracted from the Framework Study:

1. **Power Plant Siting** — A comprehensive power plant siting program should be developed and implemented that includes provisions for the construction of surface storage structures needed to ensure the integrity of the interior streams' minimum protected flows set by the Iowa Natural Resources Council.
2. **Use of Existing Reservoir Supplies** — Studies are needed to determine the feasibility of reallocating water supplies in existing federal reservoirs.
3. **Thermal Pollution** — Because energy facility siting and development must consider optimal use of all natural resources, including land, water, and energy, as well as capital costs, once-through cooling on the border streams should be considered if it can be shown that no significant harm to the environment will occur.

Commercial and Recreational Navigation

Iowa's border rivers—the Mississippi and Missouri—serve as recreational areas and provide important transportation routes for waterborne commerce. Since the Iowa Department of Transportation (IDOT) was created, increasing attention has been given to the development of these aspects of the rivers. But continued multi-agency coordination, both state and federal, is needed in view of the interstate nature of the valuable river corridor along each border river. Additional recreational participation with other river basin commissions, as well as other federal agencies, is a continued need. **Water Plan '78** recognizes these important planning elements:

1. **Mississippi Lock and Dams** — The Mississippi River's navagational system is an important transportation link for moving the state's bulk agricultural products and the system should be maintained and rehabilitated to preserve its integrity. However, the state opposes a twelve-foot navigational channel and seriously questions the feasibility of a year-round navigation season. The concept of a user fee for barge traffic that encourages a balanced transportation system should be studied and given serious consideration.
2. **Recreation-Commercial Coordination** — Serious conflicts between commercial and recre-

ational users on the Mississippi River have arisen, and the state and federal government must develop and implement new management techniques to better coordinate these users.

3. **Barge Terminal Siting** — The siting of barge terminals along the Mississippi River should be carefully planned and located to ensure minimal conflicts among competing shoreline uses and a cost-efficient transportation system.
4. **Missouri River Navigation and Bank Stabilization Project** — An evaluation of this project should be completed as soon as possible; the channel degradation problem is considered to be extremely serious and remedial measures should be commenced under federal programs of the U.S. Army Corps of Engineers (See recommendations in Fish and Wildlife section).

Agricultural Water Use

Agriculture, with intensive cultivation of over half of the land area of the state, has first claim to the state's precipitation; the water being utilized through the transpiration of soil moisture by growing plants. Studies of the severe droughts of the 1950's and 1970's have shown that moisture shortages are most critical in western and northwestern Iowa, and on sandier soils. Irrigation may be profitable in these areas. Specialty crops also may warrant irrigation. Otherwise, precipitation is sufficient in most years, making supplemental irrigation of doubtful long-term economic value. Livestock watering is an essential water need, and regional rural systems have provided water of better quality and more reliable quantity.

Soil erosion and sediment problems and the threat of water contamination by agricultural chemicals and livestock waste residues make agriculture an important factor in the state's water quality control program. Water Plan '78 summarizes these urgent considerations:

1. **Irrigation** — Water allocation policies should acknowledge that where water supplies are available, supplemental irrigation should have high priority in (a) western and northwestern Iowa, (b) on the sandier alluvial soils of the state, or (c) for specialty crops needing supplemental water. Otherwise, the practice of supplemental irrigation should not be encouraged pending additional physical and economic research. In western and northwestern Iowa, where groundwater supplies are insufficient to meet this large consumptive demand, further development may depend on storage or water transfer.
2. **Soil Conservation and Non-point Source Pollution** — An increased emphasis on the control of non-point source pollution requires the development of improved conservation practices, increased funding to implement them, and strict enforcement of soil loss regulations to cope with Iowa's severe pollution problems caused by agricultural runoff. The Department of Soil Conservation and Environmental Quality are currently developing such an action program.

A Mississippi River towboat passing the Dubuque Commercial Harbor *Iowa Development Commission*

Sailing at sunset, Clear Lake *Iowa Conservation Commission*

Law and Government

Water resource management in Iowa involves over thirty agencies at the state, county, muncipal, and special-purpose district levels of government. These agencies administer numerous and often interdependent programs. A summary matrix of these programs and the agencies that administer them is provided in Figure 19.

State Level

While there are numerous state agencies having water resource management programs, five agencies carry the primary responsibility for this management: the Iowa Natural Resources Council (INRC), the Department of Soil Conservation (DSC), the Department of Environmental Quality (DEQ), the Iowa Conservation Commission (ICC), and the Iowa Geological Survey (IGS). The internal organizational structure of these agencies is illustrated in Figure 20.

The State Comptroller's Office classifies these agencies, as well as several others, by function as "natural resource" agencies for budgetary purposes. Table 6 provides a breakdown of the general fund appropriations among various functional agency classes by the 67th General Assembly for fiscal year 1978. As the table indicates, natural resource management programs comprise less than 2 percent of all general fund appropriations. Table 7 provides a further breakdown of general fund appropriations within the natural resource functional classification for each agency.

The INRC water resource programs focus on flood plain management, regulation of water withdrawals and use, and water resource planning and coordination. Specific activities engaged in by the INRC include establishing flood plain encroachment limits, issuing flood plain construction permits; regulating the construction and operation of flood control projects and milldams; regulating changes in water level behind dams; processing applications and issuing permits for diversion, storage, and withdrawal of water for uses subject to the permit system; preparing and updating a water plan for control, utilization, and protection of the state's water resources; coordinating federal water resource projects with state, county, and local needs; and regulating oil and gas well drilling and the use of water in the drilling process.

The DSC administers the state's surface mined land reclamation program, assists the state's six conservancy districts (CD's) and 100 soil conservation districts (SCD's), in administration of soil erosion abatement programs, and engages in nonpoint source water pollution abatement planning in cooperation with DEQ and EPA.

The DEQ administers the state's air, land, and water pollution control and abatement programs. In addition, DEQ also administers a public water supply program that involves setting of safe drinking water standards; regulating construction, operation, and maintenance of public water supply and distribution systems; and preparing a safe drinking water emergency plan for the state. Other DEQ programs indirectly affecting water quality include regulatory programs relating to sanitary landfill projects, spill prevention and cleanup of hazardous materials, land application of residual wastes, and the sale and use of agricultural chemicals, including fertilizers and pesticides.

The ICC administers the state outdoor recreation, fish and wildlife programs and regulates construction of the beds of the state's meandered streams. The outdoor recreation programs include acquisition, development, and operation of state parks, waters, forests, recrea-

FIGURE 19 Agency-Program Matrix of Iowa's Water and Related Land Resources

INSTITUTION / WATER RELATED ACTIVITY	Water Withdrawal, Diversion	Water Level and Flow	Public Water Supply	Agricultural Chemical Use	Discharge into Water	Sewage Disposal	Solid Waste Disposal	Commercial Feedlots	Other Water Quality	Dams / Water Impoundments	Farm Ponds	Reservoirs	Flood Plain Activities	Drainage	Soil Conservation	Mining	Oil and Gas Wells	Water Wells	Weather	Electric Power	Piers and Docks	Dredging, Gravel Removal	Shoreline Alteration	Roads and Bridges	Fish and Game	Parks and Outdoor Recreation	Navigation	Scenic, Landscape Preservation	Zoning	Water and Related Land Planning
STATE AGENCY:																														
Iowa Natural Resources Council	R[1]	R[2]	R[3]		R[4]			R[5]	R[6]	R[7]	R[8]	R[7]	R[9]	R[10]			R[11]	R[1]		R[1]	R[9]	R[9]	R[9]	R[9]			R[12]	N[13]	R[14]	R[15]
Department of Environmental Quality			R[16]	R[17]	R[18]	R[19]	R[20]	R[21]	R[22]	R[23]				R[24]	N[25]	R[22]		R[16]		R[26]	R[22]	R[22]	R[22]	R[22]						R[27]
Department of Soil Conservation									N[28]					R[29]	R[30]	R[31]						R[31]	R[30]					R[31]		N[32]
Iowa Geological Survey	N[33]	N[33]	N[33]		N[33]										N[33]	N[34]	R[35]	N[36]	N[33]											N[33]
Iowa Conservation Commission										R[37]	N[42]	R[39]			N[38]						R[39]	R[40]	R[39]	R[41]	R[42]	R[43]	R[44]	N[45]	N[45]	N[46]
Department of Health			R[47]			R[47]								R[47]																
Department of Agriculture				R[48]															N[49]											
Iowa Commerce Commission			R[50]						R[50]											R[51]										R[52]
Department of Transportation														N[53]	R[54]								R[54]	R[55]		N[56]	N[57]	N[56]		N[58]
Iowa Development Commission																										N[59]				
Energy Policy Council																N[60]	N[60]			N[60]										N[60]
Office for Planning and Programming																														N[61]
Executive Council												N[62]								R[63]						N[64]				
State Hygienic Lab									N[65]																					
Historic Department																												N[66]		N[66]
Mississippi Parkway Planning Commission																								N[67]		N[67]				N[67]
State Extension							N[68]	N[68]	N[68]	N[68]		N[68]			N[68]	N[68]														N[69]
SPECIAL PURPOSE DISTRICTS:																														
Conservancy District										N[70]	N[70]			N[70]	N[70]	N[70]														N[71]
Soil Conservation District										N[72]	N[72]			N[72]	N[72]	R[72]							N[72]							N[73]
Drainage or Levee Districts						N[74]				N[75]			N[75]	N[75]	N[75]								N[76]							
Erosion and Flood Control										N[77]			N[77]	N[77]	N[77]	N[77]							N[77]							
County Agricultural Extension District					N[78]	N[78]	N[78]		N[78]		N[78]		N[78]	N[78]	N[78]								N[78]							
Rural Water District	N[79]	N[79]	N[79]							N[79]		N[79]						N[79]												N[82]
Benefited Water District	N[80]	N[80]	N[80]							N[80]		N[80]						N[80]												N[82]
Sanitary District	N[81]	N[81]				N[81]																								N[82]
Metropolitan or Regional Planning Commission																														N[82]
COUNTY			R[83]			R[84]	R[85]						R[86]	R[87]	N[86]	N[86]			N[88]				N[86]	N[89]	N[90]	N[90]		N[90]	N[91]	N[92]
MUNICIPAL	←															R[93]														→

KEY

R— Agency has regulatory power over private sector actions involving the water related activity.

N— Agency has power to implement programs involving the water related activity.

The numerical superscripts to "R" and "N" refer to footnotes citing pertinent Iowa Code sections. The footnotes are part of the Law and Government Task Force Report, but they have been omitted from the Framework Study due to their length.

tional areas, and preserves; preparation of an outdoor recreation plan; designation of scenic rivers; supervision of county conservation boards; and regulation of recreational navigation. The fish and wildlife programs include establishment and enforcement of sport and commercial fish and game laws; operation of fisheries and game farms; and acquisition and maintenance of fishing, game management, and hunting areas.

The IGS is unique among the state's water resource agencies. Unlike the above agencies, IGS is not required to regulate, develop, or manage any natural resources. Instead, it is authorized to engage in research and data collection. In this capacity, IGS provides extensive technical assistance to other agencies and the public. In particular, IGS provides significant technical support services relating to water availability and water quality needed by the INRC and DEQ in administering their water related programs. Private well drillers also rely heavily on IGS data. Some of the research and data-collecting activities of IGS include monitoring stream flows for quantity and quality, in cooperation with the U.S. Geological Survey; preparing the basic water availability data for INRC's Water Plan '78; investigating the state's underground water supplies; mapping of flood plains with sophisticated aerial photography; studying the economic feasibility of irrigation and coal mining in Iowa; assisting DEQ in establishment of geological criteria for selection of sanitary landfill sites; and investigating thermal water pollution.

Besides the above five agencies, other state agencies with less extensive responsibility in water resource management include the Iowa State Commerce Commission, Department of Health, Department of Transportation, Department of Agriculture, Iowa State Historical Department, Energy Policy Council, Iowa Development Commission, Office of Planning and Programming, Executive Council, Department of Public Defense, Mississippi River Parkway Commission, Inter-Agency Resource Council, and various research and service institutes affiliated with the state university system.

County Level

County government is vested with various duties and powers directly or indirectly affecting water resources. Many of these powers are vested in the county board of supervisors, while others are vested in administrative subunits of the county, such as the county conservation board, the county board of health, the zoning commission, or the weather modification board. These county agencies are involved in flood and soil erosion control; water quality, principally through the regulation of waste disposal; establishing of rural water districts; investigate, develop, and evaluate weather modification programs; and general land use controls that may affect water resources.

TABLE 6 67th General Assembly Appropriations from the General Fund for FY 1978* and Governor's Recommendation for FY 1979 by Agency Function**

Agency Function	1978 FY		Gov. Rec. for FY 1979	
	Appropriation	Percentage	Appropriation	Percentage
State Departments	74,800,075	5.35	83,938,750	5.61
Education	717,998,167	51.42	776,441,519	51.85
Human Resources	266,988,047	19.12	283,347,006	18.92
Transportation and Law Enforcement	28,890,720	2.06	31,477,470	2.10
Natural Resources	17,833,051 (24,063,051)+	1.27 (1.72)+	22,115,601 (28,365,601)++	1.48 (1.90)++
Miscellaneous Tax Credits, Aids, Inc. Offsets, and Tax Refunds	289,580,077 (283,350,077)+	20.74 (20.29)+	300,014,486 (293,764,486)++	20.04 19.62 ++
TOTAL General Fund Appropriations	**1,396,090,137**	**100**	**1,497,334,832**	**100**

*Source: Exhibit D from "State of Iowa General Fund Statement, July, 1977" prepared by the State Comptroller (dated October 12, 1977).

**Source: Exhibit D of Governor's Budget Supplement to the Second Session of the 67th General Assembly (dated January 11, 1978).

+Percentage Adjusted to reflect DEQ sewage grant aid of $2,000,000 and DSC conservation cost share of $4,230,000 inclusion in Natural Resource category and exclusion from Miscellaneous Tax Credit and Aids category.

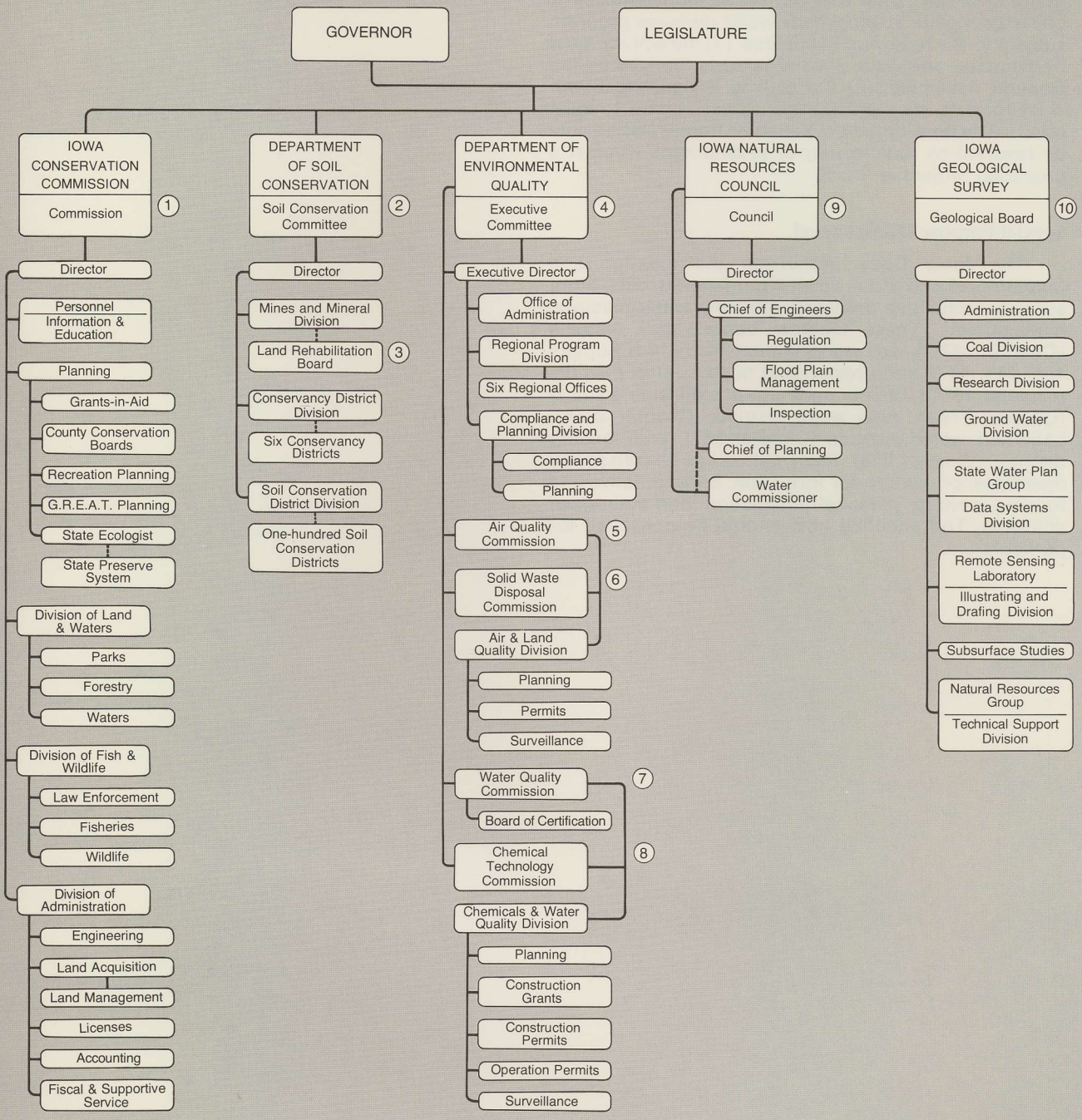
++Percentage Adjusted to reflect DEQ sewage grant aid recommendation of $2,000,000 and DSC conservation cost share recommendation of $4,250,000 inclusion in Natural Resource category and exclusion from Miscellaneous Tax Credit and Aids category.

TABLE 7 The 67th General Assembly Appropriations to State Natural Resources Agencies

State Agency	(1) General Fund Appropriation	(2) Percent of Total General Fund Appropriations	(3) Percent of General Fund Appropriated to Natural Resource Agencies	(4) Trust and Revolving Fund Appropriations [d]	(5) Total Departmental Appropriations [e]	(6) Percent of Total Departmental Appropriations To Natural Resource Agencies [f]
ICC	5,536,562	.39	23.00	7,245,456	12,782,018	38.68
DSC	6,716,602 [g]	.48	27.91	—	6,716,602	20.33
Dept. of Agriculture	3,577,245	.25	14.86	1,729,324	5,306,569	16.06
DEQ	3,922,224 [g]	.28	16.29	—	3,922,224	11.87
IDC	1,823,918	.13	7.57	—	1,823,918	5.52
IGS	1,147,650	.08	4.76	—	1,147,650	3.47
Fair Board	580,800	.04	2.41	—	580,800	1.75
INRC	521,857	.03	2.16	—	521,857	1.57
EPC	210,193	.01	.87	—	210,193	.63
Hoover Foundation	20,000	—	.08	—	20,000	.06
Miss. River Parkway Comm.	6,000	—	.02	—	6,000	.01
TOTAL	**24,063,051**	**1.72**	**100**	**8,974,780**	**33,037,831**	**100**

(a) Source: Pages 20-22 of Schedule D-1, "Iowa General Fund Statement, July 1, 1977", prepared by the State Comptroller (dated 10/12/77) (hereinafter referred to as 1977 General Fund Statement).
(b) Total General Fund appropriations for fiscal year 1977-1978 is $1,396,090,137. See Exhibit D, 1977 General Fund Statement.
(c) (Col. 1) $24,063,051 × 100%
(d) Source: Comptroller's Office
(e) Col. (1) + Col. (4)
(f) Col. 5 $33,037,831 × 100%
(g) Figures adjusted to include $2,000,000 appropriated to DEQ for sewage works construction and $4,230,000 appropriated to DSC for conservation cost share.

FIGURE 20 Organizational Structure of Iowa's Five Agencies Having Primary Responsibility for Water Resource Management



1. The Conservation Commission consists of seven citizens knowledgeable in conservation matters who are appointed by the Governor with the approval of two-thirds of the Senate. No more than four may be of the same political party when appointed.
2. The State Soil Conservation Committee consists of six farmers, one city representative and one mining representative who are all appointed by the Governor with Senate confirmation, and five ex officio nonvoting members.
3. The Land Rehabilitation Board serves in an advisory capacity to the Department of Soil Conservation and consists of a geologist, forester, agronomist, two surface mine operators, and representatives of the Soil Conservation Committee and the Iowa Natural Resources Council.
4. The Executive Committee consists of the chairpersons of the four department commissions and six nonvoting ex officio members.
5. The Air Quality Commission consists of one farmer, one manufacturer and two electors of the state, who are all appointed by the Governor with two-thirds Senate approval, and the president of the Iowa Medical Society.
6. The Solid Waste Disposal Commission consists of one farmer, one manufacturer and two electors of the state, who are all appointed by the Governor with two-thirds Senate approval, and the president of the Iowa Engineering Society.
7. The Water Quality Commission consists of one farmer, one manufacturer and two electors who are all appointed by the Governor with two-thirds Senate approval, and the chairperson of the Iowa Development Commission
8. The Chemical Technology Commission consists of a chemical manufacturer and a farmer, who are appointed by the Governor with two-thirds Senate approval, and seven ex officio members.
9. The Iowa Natural Resources Council consists of nine voting members appointed by the Governor with two-thirds Senate approval, and one nonvoting ex officio member representing the Department of Environmental Quality.
10. The Iowa Geological Board consists of the Governor, Auditor of the State, presidents of Iowa State University, and The University of Iowa and president of the Iowa Academy of Science.

--- Denotes an administrative or coordinating relationship.

Urban Level

Under the 1968 state constitutional amendment, granting broad home rule powers to municipalities, a city may engage in almost any water resource program subject to the following limitations: (1) the activity must be financed only from special taxes authorized by the General Assembly; (2) the activity is consistent with existing state law; and (3) the activity relates to local affairs. The final limitation placed on home rule can only be resolved by judicial degree to determine whether a proposed project is "local".

Special-Purpose District Level

The **Iowa Code** authorizes the creation and operation of numerous special-purpose districts. Eight such districts have programs affecting water resource management. These include: conservancy districts (Chapter 467D), soil conservation districts (Chapters 455, 456, 457), soil erosion and flood control districts (Chapter 467C), county agricultural extension districts (Chapter 176A), rural water districts (Chapter 357A), benefited water districts (Chapter 357), and sanitary districts (Chapter 358). Each district has its own policy mandates, procedure for formation, administrative and funding powers, personal jurisdiction, and authorized activities. The enabling acts should be consulted for particulars.