WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY

IN NEBRASKA, FISCAL YEARS 1993-94

Compiled by Anna M. Sojka and Daniel J. Fitzpatrick

U.S. GEOLOGICAL SURVEY

Open-File Report 94-92

Lincoln, Nebraska
1994

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

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square mile	2.590	square kilometer

MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey (USGS) is known for its impartial fact-finding research mission and, as such, has been involved in the collection and interpretation of hydrologic information in Nebraska for more than 100 years. This information, published in numerous reports and papers, enables managers to make decisions based on objective information. This report is designed to inform managers and other interested persons of the current hydrologic-data programs and investigative water-resources activities of the USGS in Nebraska from 1993 to 1994.

The water-related studies of Nebraska are supported through joint-funding agreements with State and local agencies, through Federal funds from direct Congressional appropriations, and through reimbursable funding from other Federal agencies. Jointly funded programs, considered when the study is mutually advantageous to the State or local agency as well as to the USGS, continue to enhance the program of the USGS in Nebraska and to provide important hydrologic information for State, local, and national needs. In most cases, costs are shared equally. These cooperative, jointly funded programs are reviewed and renegotiated annually to ensure that they are responsive to the needs of the State and to the national priorities of the USGS. Another significant contribution to the program in Nebraska is the collection and interpretation of hydrologic data in support of other Federal agencies (OFAs). The coordination of hydrologic activities with OFAs increases efficiency at the Federal level and stretches ever-decreasing resources.

In 1991, the USGS implemented a full-scale National Water-Quality Assessment (NAWQA) program. The long-term goals of the NAWQA program are to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary human and natural factors affecting the quality of these resources. The Central Nebraska Basins NAWQA is underway as one of the first 20 study units selected for full implementation.

Quality has been a priority with the USGS since the agency was created, and Nebraska District personnel continually strive to ensure that the agency's high standards are maintained. To carry out our mission effectively and to ensure customer satisfaction, we need and encourage feedback from everyone we serve.

If you would like more information about water-resources activities in Nebraska, please contact me at (402) 437-5082. Information on other activities of the USGS are given in the "Sources of U.S. Geological Survey Publications and Information" section of this report.

Linda S. Weiss
District Chief
Nebraska District

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN NEBRASKA, FISCAL YEARS 1993-94

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ABSTRACT

Water-resources activities of the U.S. Geological Survey in Nebraska consist principally of hydrologic data collection and local, areal, or statewide interpretive studies. These programs are funded by cooperative agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal funds. The data and results of the investigations are published or released either by the U.S. Geological Survey or by cooperating agencies. This report describes the hydrologic data-collection programs and local or areal hydrologic investigations in Nebraska during fiscal years 1993 and 1994 and provides a list of reports released by the Nebraska District during 1985-93.

U.S. GEOLOGICAL SURVEY ORIGIN AND MISSION

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating the Earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the U.S. Geological Survey has increased and been modified to meet the changing needs of the Nation it serves. Today's programs serve a diversity of needs and users. These programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.

- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.

- Providing Earth-science information through an extensive publications program and a network of public-access points.

Along with its continuing commitment to meet the growing and changing Earth-science needs of the Nation, the U.S. Geological Survey remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "Earth Science in the Public Service."

WATER RESOURCES DIVISION MISSION AND PROGRAM

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.

- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.

- Conducting basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific knowledge for investigations and measurement techniques.

- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public release.

- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.

- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the Department of State.

NEBRASKA DISTRICT ORGANIZATION

The Nebraska District office of the U.S. Geological Survey, Water Resources Division, under the direction of Linda S. Weiss, is headquartered in Lincoln, Nebraska. The District office consists of five sections: Hydrologic Investigations, the Central Nebraska Basins National Water-Quality Assessment (NAWQA), Hydrologic Data and Quality Assurance, Administrative Services, and Computer Services (fig. 1). Field headquarters for the Hydrologic Data and Quality Assurance Section are located in Lincoln, North Platte, and Ord, Nebraska.

- The Hydrologic Investigations Section conducts both problem-oriented and resource-appraisal studies within the State and prepares reports for publication on the results of the studies. These studies analyze and interpret hydrologic and geologic systems and their relation to availability, quantity, quality, and use of water.

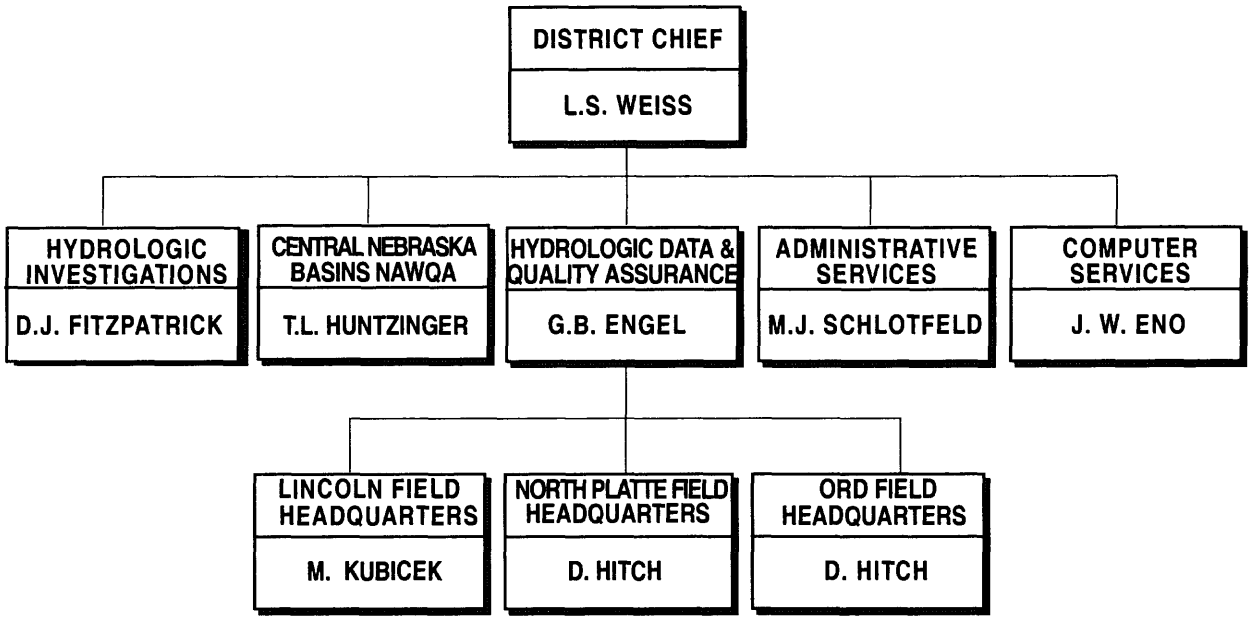


Figure 1. Nebraska District organization.

- The Central Nebraska Basins NAWQA Section conducts investigations to help meet the long-term goals of the National Water-Quality Assessment Program. These goals include the description of the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources, and providing a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources.

- The Hydrologic Data and Quality Assurance Section designs, constructs, operates, and maintains all hydrologic-data networks in the State. The Section manages the collection and analysis of the hydrologic data for the State network, processes and reviews data for publication, prepares water-resources data for the annual water-data report, and provides quality control of results for field and office methods.

- The Administrative Services Section is responsible for financial management, personnel, payroll, procurement, equipment maintenance, and other administrative duties of the District.

- The Computer Services Section manages and maintains the District's computer system and coordinates processing, storage, and retrieval of data for the District and national computer files of the U.S. Geological Survey. The Section helps design, implement, and maintain the computer software necessary for District operation.

Inquiries regarding programs described in this report may be directed to the District office. Addresses for the District office, project office, and field headquarters are listed below.

District Office
Room 406, Federal Building
100 Centennial Mall, North
Lincoln, NE 68508
(402) 437-5082

Central Nebraska Basins NAWQA
Project Office
4821 Quail Crest Place
Lawrence, KS 66049-3839
(913) 832-3514

Lincoln Field Headquarters
Room 406, Federal Building
100 Centennial Mall, North
Lincoln, NE
(402) 437-5114

North Platte Field Headquarters
Federal Building, Room 244
300 East 3rd
North Platte, NE 69101
(308) 532-5323

Ord Field Office
Hwy. 11 North
Ord, NE 68862
(308) 728-5601

NEBRASKA DISTRICT FUNDING

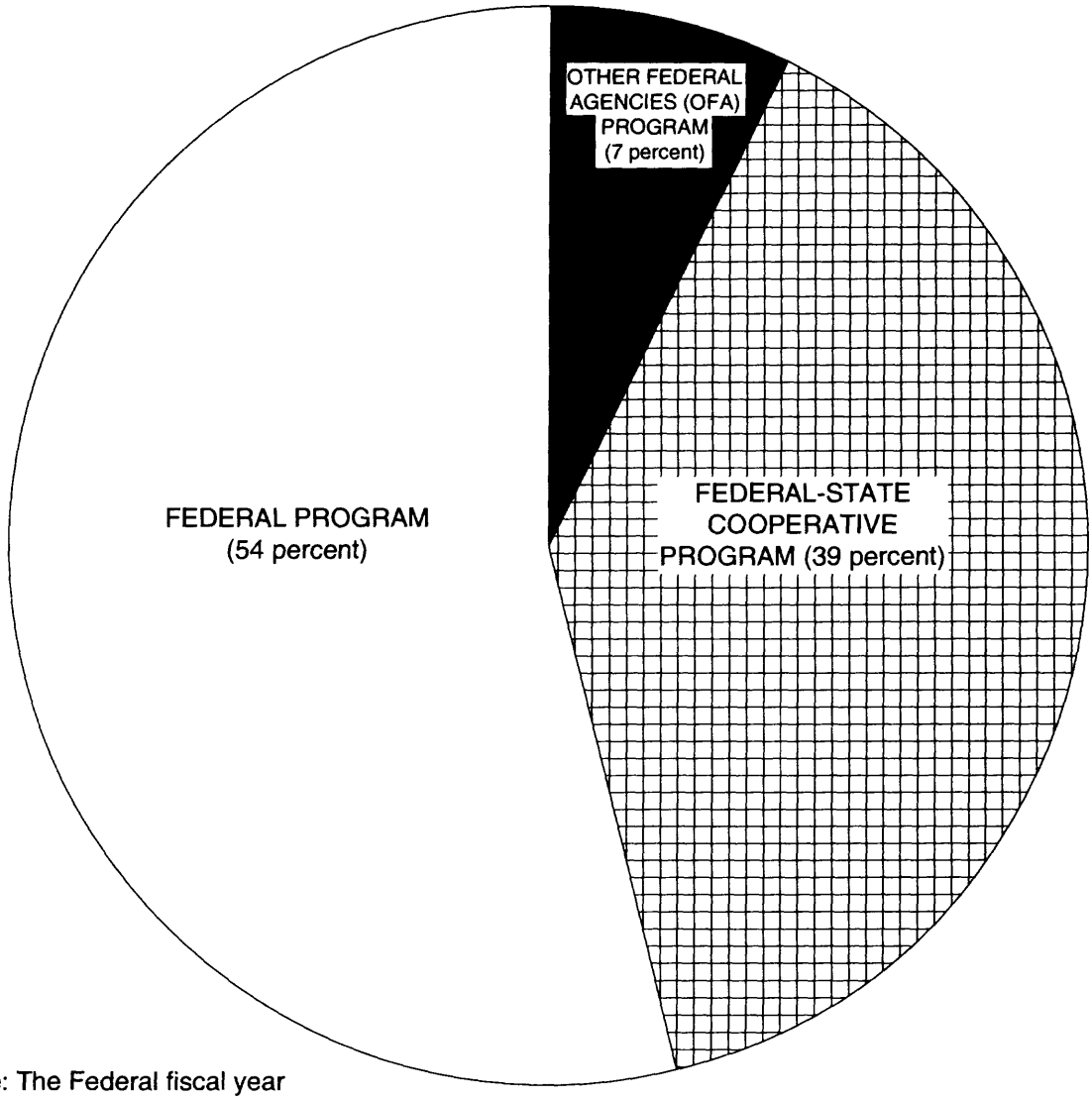
Programs of the Water Resources Division in Nebraska are funded as follows: (1) The Federal program, in which funds are appropriated annually by Congress to the Geological Survey; (2) the Federal-State cooperative program, in which the Water Resources Division represents national interests, the cooperating agencies represent State and local interests, and the funding generally is shared equally; and (3) other Federal agencies (OFAs) program, in which funding is received from another Federal agency. Distribution of funding for program operation during fiscal year 1993 is shown in figure 2.

COOPERATING AGENCIES

Most of the Nebraska District programs are carried out by joint-funding agreements with State, local, or other Federal agencies. During fiscal years 1993 and 1994, the following agencies contributed funds and(or) services to cooperative programs with the Nebraska District:

- Kansas-Nebraska Big Blue River Compact Administration
- Nebraska Department of Environmental Quality
- Nebraska Department of Water Resources
- Nebraska Natural Resources Commission
- Nebraska Natural Resources Districts (NRD's):

  Central Platte, Little Blue, Lower Elkhorn, Lower Platte North, Lower Platte South, Lower Republican, Middle Republican, Nemaha, North Platte, Papio-Missouri River, South Platte, Upper Big Blue, Upper Elkhorn, Upper Loup, Upper Niobrara-White, and Upper Republican
- University of Nebraska-Lincoln, Conservation and Survey Division
- City of Lincoln
- City of Omaha
- U.S. Army Corps of Engineers
- U.S. Bureau of Reclamation
- U.S. Environmental Protection Agency
- U.S. Department of Energy



Note: The Federal fiscal year begins October 1 and ends September 30

Figure 2. Distribution of funding, fiscal year 1993.

WATER CONDITIONS AND RESOURCES

An abundant supply of water is available in Nebraska for most uses, although quantity varies areally as well as seasonally and annually. Rainfall is extremely variable across the State, ranging from about 17 inches in the Panhandle to about 37 inches in the southeast (Boohar, Hoy, and Steele, 1993). Runoff, too, is extremely variable, with annual amounts ranging from about 0.5 inch in the west and southwest to about 6 inches in the southeast (U.S. Geological Survey, 1986). A large percentage of the annual runoff is from snowmelt in the spring or thunderstorms in the spring and early summer.

Agriculture is the major industry in Nebraska, and irrigation constitutes the major use of surface and ground water in the State. Surface water for irrigation is obtained from reservoirs, canal systems, and directly from stream channels. Ground water is pumped from about 75,000 wells to irrigate about 6 million acres (Steele and Wigley, 1992). Ground-water development for irrigation has caused declining water levels in some areas of the State.

Water in the principal aquifers in Nebraska is suitable for most uses; however, contamination, principally from agricultural activities, is present in some areas. Large increases in the use of fertilizers and pesticides have accompanied irrigation development and have provided the potential for widespread nitrate and pesticide contamination of shallow ground water. Concentrations of nitrate as nitrogen exceed the U.S. Environmental Protection Agency Drinking-Water Regulation of 10 milligrams per liter (U.S. Environmental Protection Agency, 1988) in several areas of the State, with the most extensive of these located within the Platte River Valley (Exner and Spalding, 1990). Pesticides also are found in the ground water in many areas of the State.

NATIONAL HYDROLOGIC-DATA NETWORKS AND PROGRAMS

A significant amount of stream water-quality data is collected in Nebraska as part of the National Stream Quality Accounting Network (NASQAN). NASQAN is a data-collection effort for obtaining consistent regional and nationwide overviews of the quality of streams. The primary objectives of the network are to: (1) account for the quantity and quality of water moving within and from major river basins in the United States; (2) depict areal variability; (3) detect changes in stream quality; and (4) provide data for future assessments of changes in stream quality. Seven NASQAN stations are included in the Nebraska District's hydrologic data-collection program.

The National Water-Use Information Program of the U.S. Geological Survey is a Federal-State cooperative program designed to collect, store, and disseminate water-use information nationally and locally. The program was begun during 1978 to meet the need for a single source of uniform information on water use. Information on the National Water-Use Information Program and its data bases can be obtained from:

National Water-Use Information Program
U.S. Geological Survey
440 National Center
Reston, VA 22092

As part of the U.S. Geological Survey's program of releasing water data to the public, a large-scale, computerized system is used for the storage and retrieval of water data. U.S. Geological Survey water-resources data are maintained on the National Water Data Storage and Retrieval System (WATSTORE) at the central computer facilities in Reston, Virginia. A pamphlet, "WATSTORE: A WATer Data STOrage and REtrieval System," may be obtained from the WATSTORE Program office, Branch of Computer Technology, U.S. Geological Survey, 440 National Center, Reston, VA 22092, telephone (703) 648-5680.

In addition, much of these data are stored and available on District minicomputer files using a distributed information system (DIS). The DIS configuration provides easy dissemination and access of data that pertain to a given State. These data are available for water planning and management in machine-readable form, computer-printed tables or graphs, statistical tabulations, and digital plots. Information about the availability of specific types of data, the acquisition of data or products, and user charges can be obtained from the District office in Lincoln.

NEBRASKA DISTRICT PROGRAMS

Hydrologic data-collection stations are maintained by the U.S. Geological Survey throughout Nebraska to obtain records of stream discharge or stage, lake and reservoir storage, ground-water levels, and quality of surface and ground water. On October 1, 1993, there were 132 continuous-record stations in operation, which included 5 continuous-record lake stations. There were also 5 partial-record lake stations and 4 partial-record stream sites for water quality in operation. Records of physical, chemical, microbiological, or radiochemical quality of water were published for 20 stream sites and 250 wells. Table 1 lists current surface-water gaging stations, in downstream order, and the type of data collected at each station. The location of active surface-water gaging stations is shown in figure 3, and the location of active surface-water-quality stations is shown in figure 4.

Ground-water levels are measured routinely in a network of selected observation wells in Nebraska (table 2). These data are intended to provide a sampling and historical record of water-level changes in the most important aquifers. The location of the observation wells in this network is shown in figure 5. In addition to data collected as part of this network of selected observation wells, ground-water levels are compiled through efforts of many Federal, State, and local agencies for several thousand observation wells throughout Nebraska, and these data are placed in computer storage. Each year the Nebraska District and the Conservation and Survey Division of the University of Nebraska publish a report for the previous calendar year entitled "Groundwater Level Changes in Nebraska, 19__." Hydrologic data collected in Nebraska are published annually in a report entitled "Water Resources Data, Nebraska, Water Year 19__" (the water year is from October 1 to September 30 of the following year). These reports are available for inspection at the U.S. Geological Survey in Lincoln, Nebraska, or may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, telephone (703) 487-4650.

Snake River Falls near Burge, Nebraska.

Table 1. *Surface-water gaging stations, in downstream order, and type of data collected, fiscal year 1994*

[Type of data: D, discharge; E, elevation and contents; C, chemical; M, microbiological; S, sediment; T, temperature]

Station number (figs. 3 and 4)	Station name	Type of data
06453500	Ponca Creek at Anoka	D
06453600	Ponca Creek at Verdel	D
06454000	Niobrara River at Wyoming-Nebraska State line	D
06454500	Niobrara River above Box Butte Reservoir	D
06545500	Box Butte Reservoir near Hemingford	E
06459175	Snake River at Doughboy	D
06459300	Merritt Reservoir near Burge	E
06459500	Snake River near Burge	D
06461000	Minnechaduza Creek at Valentine	D
06461500	Niobrara River near Sparks	DC
06462500	Plum Creek at Meadville	D
06463500	Long Pine Creek near Riverview	DC
06464900	Keya Paha River near Naper	D
06465000	Niobrara River near Spencer	D
06465440	Redbird Creek at Redbird	D
06465500	Niobrara River near Verdel	DCMS
06466500	Bazile Creek near Niobrara	D
06478518	Bow Creek near St. James	D
06601000	Omaha Creek at Homer	D
06677500	Horse Creek near Lyman	D
06679500	North Platte River at Mitchell	D
06686000	North Platte River at Lisco	DCMS
06690000	Lake McConaughy near Keystone	E
06690500	North Platte River near Keystone	D
06693000	North Platte River at North Platte	D
06764880	South Platte River at Roscoe	D
06765500	South Platte River at North Platte	D
06765698	Tri-County Canal near North Platte	CS
06768000	Platte River near Overton	DCT
06770200	Platte River near Kearney	D
06770500	Platte River near Grand Island	DCS
06771500	Wood River near Gibbon	D
06772000	Wood River near Alda	D
06773050	Prairie Creek near Ovina	DCS
06773150	Silver Creek at Ovina	D

Table 1. *Surface-water gaging stations, in downstream order, and type of data collected, fiscal year 1994*--Continued

Station number (figs. 3 and 4)	Station name	Type of data
06774000	Platte River near Duncan	DCMS
06775500	Middle Loup River at Dunning	D
06775900	Dismal River near Thedford	DCMS
06776500	Dismal River at Dunning	D
06779000	Middle Loup River at Arcadia	D
06783500	Mud Creek near Sweetwater	D
06784000	South Loup River at St. Michael	DCS
06784200	Sherman Reservoir near Loup City	E
06784800	Turkey Creek near Dannebrog	D
06785000	Middle Loup River at St. Paul	DCS
06786000	North Loup River at Taylor	D
06787000	Calamus River near Harrop	D
06787300	Calamus Reservoir near Burwell	E
06787500	Calamus River near Burwell	D
06788795	Dane Creek at Ord	C
06788500	North Loup River at Ord	D
06788988	Mira Creek near North Loup	D
06788990	Mira Creek at North Loup	C
06790500	North Loup River near St. Paul	DC
06791150	Loup River near Palmer	CS
06791500	Cedar River near Spalding	D
06792000	Cedar River near Fullerton	DCMS
06792500	Loup River power canal near Genoa	D
06793000	Loup River near Genoa	D
06794000	Beaver Creek at Genoa	D
06795500	Shell Creek near Columbus	DCS
06796000	Platte River at North Bend	D
06796500	Platte River near Leshara	D
06797500	Elkhorn River at Ewing	D
09798500	Elkhorn River at Neligh	D
06799000	Elkhorn River at Norfolk	D
06799080	Willow Creek near Foster	D
06799100	North Fork Elkhorn River near Pierce	D
06799230	Union Creek at Madison	D
06799350	Elkhorn River at West Point	D
06799385	Pebble Creek at Scribner	D
06799450	Logan Creek at Pender	D
06799500	Logan Creek near Uehling	D
06800000	Maple Creek near Nickerson	DCS
06800500	Elkhorn River at Waterloo	DCMS

Table 1. *Surface-water gaging stations, in downstream order, and type of data collected, fiscal year 1994*--Continued

Station number (figs. 3 and 4)	Station name	Type of data
06801000	Platte River near Ashland	D
06803000	Salt Creek at Roca	D
06803500	Salt Creek at Lincoln	D
06803510	Little Salt Creek near Lincoln	D
06803520	Stevens Creek near Lincoln	D
06803530	Rock Creek near Ceresco	D
06803555	Salt Creek at Greenwood	D
06803920	Cottonwood Creek above Czechland Lake near Rescue	DC
06803935	Cottonwood Creek tributary near Prague	DC
06804000	Wahoo Creek at Ithaca	D
06804700	Wahoo Creek at Ashland	D
06804900	Johnson Creek near Memphis	D
06805500	Platte River at Louisville	DCMS
06806500	Weeping Water Creek at Union	D
06811500	Little Nemaha River near Auburn	D
06814500	North Fork Big Nemaha River at Humboldt	D
06815000	Big Nemaha River at Falls City	D
06821500	Arikaree River (headwaters of Kansas River) at Haigler	D
06823000	North Fork Republican River at Colorado-Nebraska State line	D
06823500	Buffalo Creek near Haigler	D
06824000	Rock Creek at Parks	D
06824500	Republican River at Benkelman	D
06827500	South Fork Republican River near Benkelman	D
06828500	Republican River at Stratton	D
06829000	Swanson Lake near Trenton	E
06829500	Republican River at Trenton	D
06831500	Frenchman Creek near Imperial	D
06832000	Enders Reservoir near Enders	E
06832500	Frenchman Creek near Enders	D
06834000	Frenchman Creek at Palisade	D
06835000	Stinking Water Creek near Palisade	D
06835500	Frenchman Creek at Culbertson	D
06836500	Driftwood Creek near McCook	D
06837000	Republican River at McCook	D
06837300	Red Willow Creek above Hugh Butler Lake	D
06837390	Hugh Butler Lake near McCook	E
06837500	Red Willow Creek near McCook	D
06838000	Red Willow Creek near Red Willow	D
06841000	Medicine Creek above Harry Strunk Lake	D
06842000	Harry Strunk Lake near Cambridge	E

Table 1. *Surface-water gaging stations, in downstream order, and type of data collected, fiscal year 1994*--Continued

Station number (figs. 3 and 4)	Station name	Type of data
06842500	Medicine Creek below Harry Strunk Lake	D
06843500	Republican River at Cambridge	D
06844000	Muddy Creek at Arapahoe	D
06844210	Turkey Creek at Edison	D
06844500	Republican River near Orleans	DC
06847000	Beaver Creek near Beaver City	D
06847500	Sappa Creek near Stamford	D
06849000	Harlan County Lake near Republican City	E
06849500	Republican River below Harlan County Dam	D
06851000	Center Creek at Franklin	D
06851500	Thompson Creek at Riverton	D
06852000	Elm Creek at Amboy	D
06852500	Courtland Canal at Nebraska-Kansas State line	D
06853020	Republican River at Guide Rock	D
06879900	Big Blue River at Surprise	D
06880000	Lincoln Creek near Seward	D
06880500	Big Blue River at Seward	D
06880800	West Fork Big Blue River near Dorchester	D
06881000	Big Blue River near Crete	D
06881200	Turkey Creek near Wilber	D
06881500	Big Blue River at Beatrice	D
06882000	Big Blue River at Barneston	DCM
06883000	Little Blue River near Deweese	D
06883940	Big Sandy Creek at Alexandria	D
06884000	Little Blue River near Fairbury	D
06884025	Little Blue River at Hollenberg, Kansas	DCM

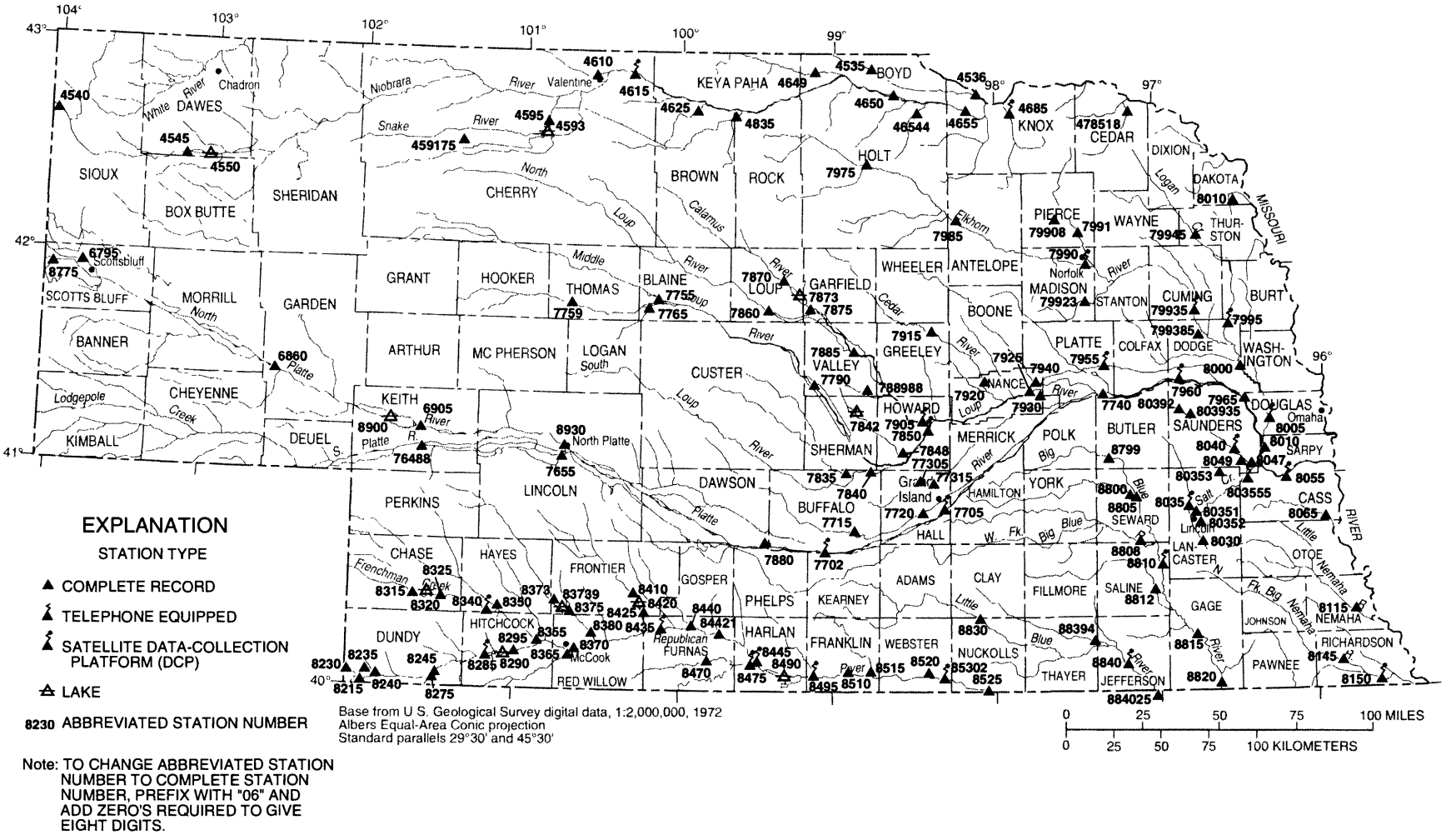


Figure 3. Location of active surface-water gaging stations, fiscal year 1994.

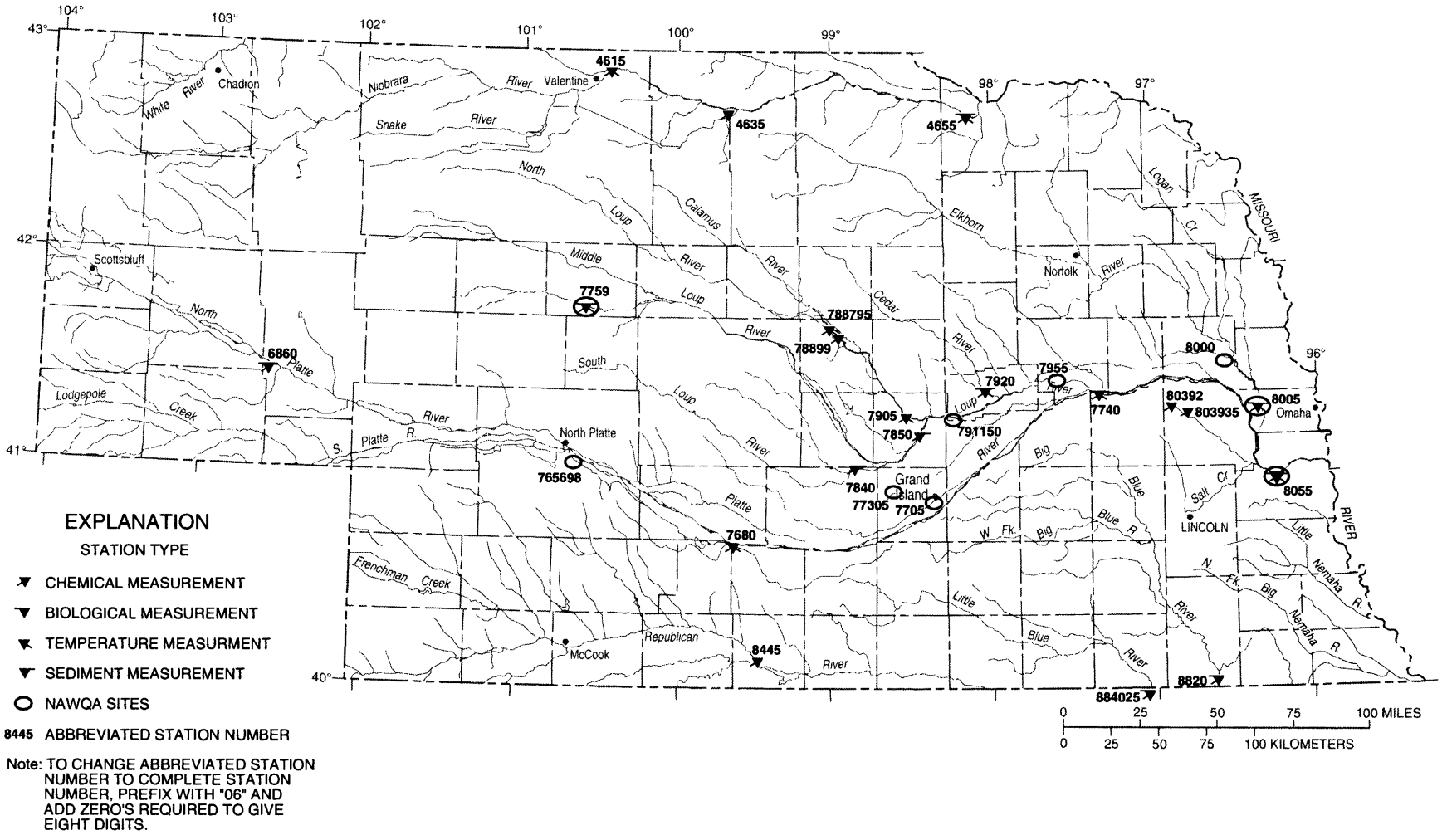


Figure 4. Location of active surface-water-quality stations, fiscal year 1994.

Table 2. *Selected observation wells in Nebraska, 1993*

County	Local well number	County	Local well number
Adams	6N11W17CB	Dundy	3N40W16BBB
Adams	7N10W23AB	Dundy	4N38W30BBC
Antelope	23N6W28DC	Fillmore	5N4W12BDC
Antelope	27N5W17AAA	Fillmore	7N1W19AA2
		Fillmore	8N2W26AD
Banner	19N54W8ACBB		
Banner	20N53W26ABAB	Franklin	4N14W23CC
Boone	19N7W2BBC	Frontier	6N25W4DDB
Box Butte	25N48W12CC	Furnas	4N24W2BAAB
Box Butte	25N50W34BDCD		
Box Butte	26N50W20CBBB	Gage	2N5E8AD
Brown	30N21W19CC	Hall	9N9W14AAB
		Hall	9N9W14AAB2
Buffalo	9N14W1CD	Hall	11N11W25CC2
Buffalo	10N16W5DC	Hall	11N12W12BCB
Buffalo	10N16W8BAAA		
		Hamilton	10N6W27ACAA
Butler	13N4E17ABA	Hamilton	11N7W3CCB
Butler	13N4E36AAAA	Hamilton	12N5W23CCC
Butler	15N1E27DD2		
		Harlan	2N18W9BCC
Cass	13N13E31CAA	Harlan	3N19W10CDAA
		Harlan	4N18W15AD
Chase	6N41W21CCC		
Chase	7N38W29CBB	Hayes	7N33W35DDD
Chase	7N41W11DAA		
		Hitchcock	4N34W34DDD
Cheyenne	13N50W4ADDD		
Cheyenne	16N49W19BBB	Holt	26N12W26AAA
		Holt	27N9W23ACCC
Clay	6N8W21DD	Holt	30N10W32DAA
Clay	8N7W23BB	Holt	31N14W27DDD
Custer	18N22W24CCCC	Hooker	24N35W8BCCC
Dawson	9N20W10ADDD	Howard	14N11W22DD
Dawson	10N21W18DDD		
Dawson	10N22W36DDA	Jefferson	4N1E31AA
Dawson	11N25W24BCB	Jefferson	4N3E13DA
Dawson	12N21W12BAAA		
		Johnson	6N9E15ADDD
Dundy	1N40W29BB2	Johnson	6N11E4DDD
Dundy	2N38W10DD		

Table 2. *Selected observation wells in Nebraska, 1993*--Continued

County	Local well number	County	Local well number
Kearney	6N15W34DC	Polk	14N2W21DB
		Polk	15N1W9BBBB
Keya Paha	33N20W19DCDD		
		Red Willow	4N27W16ABB
Kimball	15N55W7ABB		
		Saline	8N3E19ADA
Lancaster	7N6E15DCCC		
Lancaster	7N7E26CDDB	Sarpy	12N10E4BADB
Lancaster	10N7E30CCCD	Sarpy	13N10E32DBBA
Lancaster	10N7E30CDBD	Sarpy	13N13E29BCB
Lancaster	10N7E31ABDC		
Lancaster	10N7E31BACB	Saunders	13N9E13ADBA
Lancaster	10N7E31BDBD	Saunders	13N9E24DDCC
Lancaster	10N7E31CAAD	Saunders	13N9E36ABAA
		Saunders	13N10E18CDBD
Lincoln	9N26W36ADDA	Saunders	13N10E19CDDD
Lincoln	10N33W36ADD	Saunders	13N10E30CDAA
Lincoln	11N31W5BBB	Saunders	13N10E30DAAB
Lincoln	12N32W6BAB	Saunders	13N10E31ACDB
		Saunders	13N10E32CABC
Merrick	13N8W11DDDD	Saunders	13N10E32CBAB
Merrick	14N6W26AAAA	Saunders	14N8E24ACD2
Morrill	18N48W16BBCB	Scotts Bluff	22N55W11DDC
Perkins	9N35W23BBB	Seward	11N2E21DD
Perkins	9N39W2DDDD		
Perkins	11N41W4DDDD	Sheridan	29N46W10AA
Perkins	12N38W31CCCC		
		Thayer	3N4W2AA
Phelps	7N18W31AA		
Phelps	7N20W31CD	Wheeler	22N10W1BA
Pierce	28N3W33BA	York	9N4W5CCC
		York	11N2W31BA3

Middle Loup River near St. Paul, Nebraska (Photograph taken by: C.H. Carstens and Q.E. Lynch, June 1947)

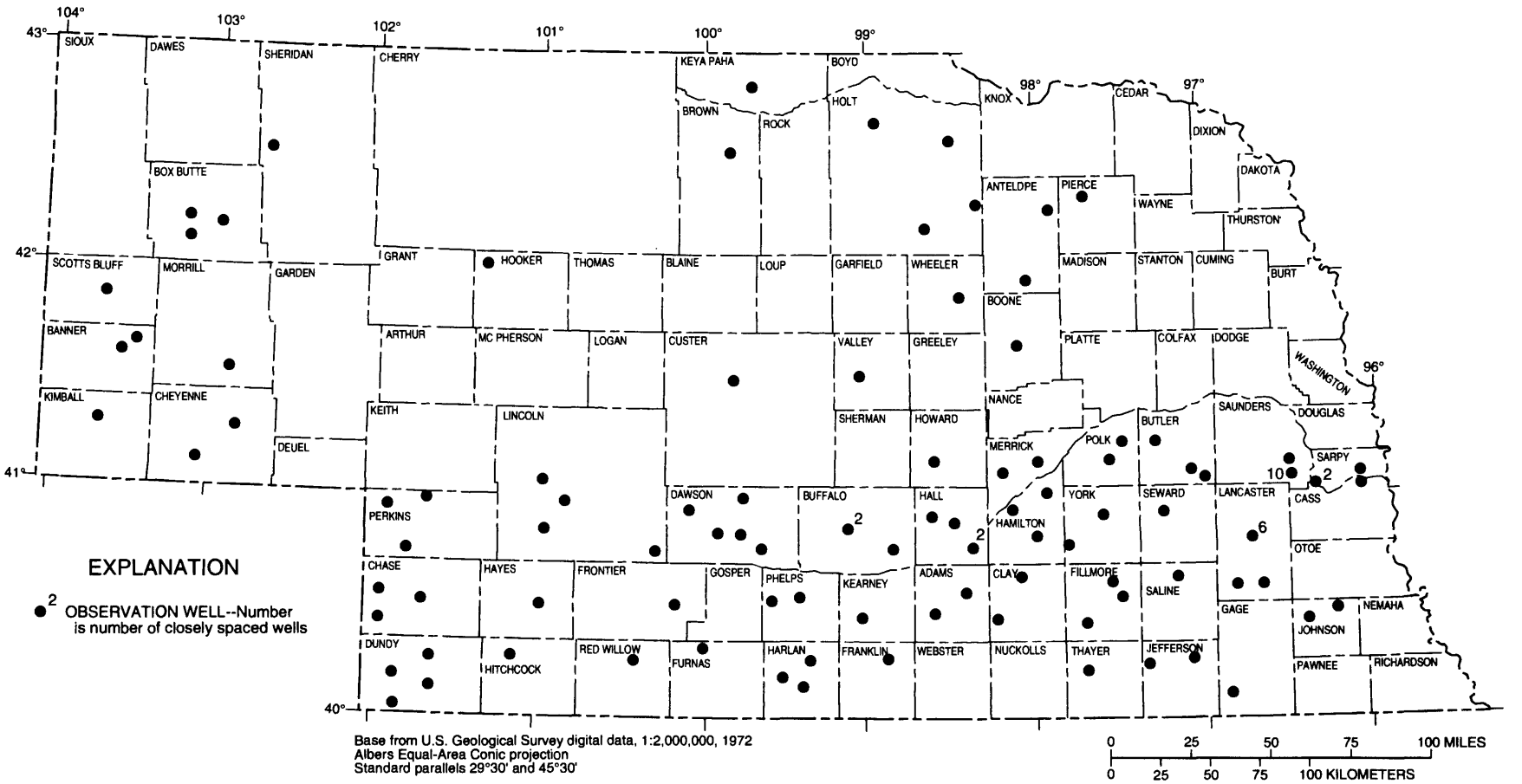


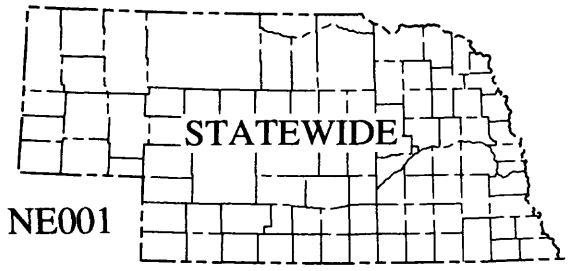
Figure 5. Location of selected observation wells, 1993.

Collection of Surface-Water Data (NE-001)

Timeframe: Continuous since 1900

Project leader: Glenn Engel

Cooperating agencies: Nebraska Department of Water Resources; Kansas-Nebraska Blue River Compact Administration; City of Lincoln; U.S. Army Corps of Engineers; U.S. Bureau of Reclamation; Central Platte NRD; and Lower Platte North NRD



NEED FOR STUDY--Surface-water information is needed for purposes of surveillance, planning, design, hazard warning, operation, and management in such water-related fields as water supply, hydroelectric power, flood control, irrigation, flood-plain management, and water-resources development. To provide this information, an appropriate and comprehensive data base is necessary.

OBJECTIVES--(1) To collect surface-water data sufficient to satisfy needs for current purposes, such as assessment of water resources, operation of reservoirs and irrigation projects, projection of stages and discharges, pollution control and disposal of wastes, discharge data to accompany water-quality measurements, compact and legal requirements, and research and special studies. (2) To collect data necessary for analytical studies to define the statistical properties of, and trends in, the occurrence of water in streams, lakes, and reservoirs for use in planning and design.

APPROACH--A network of gaging stations is maintained to provide surface-water data for management and operation, determination of long-term trends, and research and special studies. Data are collected for stage and discharge of streams or canals, stage, surface area, content of lakes and reservoirs, and temperature and precipitation. The network of stations is reviewed periodically to ensure the collection of meaningful and worthwhile data.

RESULTS--Data were collected, and annual water-year records were prepared and published in "Water Resources Data for Nebraska, Water Year 1992," U.S. Geological Survey Water-Data Report NE-92-1. At the end of fiscal year 1993, there were 129 continuous-record stations in operation, which included 5 lake stations. General maintenance and rehabilitation were performed at gages to ensure that records obtained are of highest quality and that safety measures are continued.

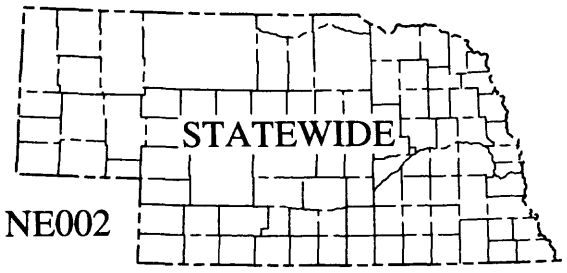
PLANS FOR FISCAL YEAR 1994--Collect data as scheduled for all continuous-record, crest-stage, and miscellaneous sites. Make additional measurements as needed to define stage-discharge ratings. Make low-flow measurements in selected areas. Perform necessary maintenance and rehabilitation. Publish streamflow records in "Water Resources Data for Nebraska, Water Year 1993."

Collection of Ground-Water Data (NE-002)

Timeframe: Continuous since 1934

Project leader: Gregory V. Steele

Cooperating agencies: University of Nebraska- Lincoln, Conservation and Survey Division; U.S. Bureau of Reclamation; U.S. Department of Energy; Lower Platte South NRD; and Nemaha NRD



NEED FOR STUDY--Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from ground-water systems, to provide a data base from which to measure the effects of development, to assist in the projection of future supplies, and to provide data for management of the resource.

OBJECTIVES--(1) To collect water-level data sufficient to provide a minimum long-term data base by which the general response of the hydrologic system to natural climatic variations and induced stresses can be better understood and potential problems can be defined early enough to allow proper planning and management. (2) To provide a data base against which the short-term records acquired in areal studies can be analyzed.

APPROACH--Develop a framework of knowledge on aquifer systems and their boundary conditions through interpretation of regional geology. Using this framework and knowledge of stresses on the systems in time and space, select locations advantageous for observing long-term system responses. Establish and maintain a network of observation wells from which water-level records are obtained. Analyze these records and information obtained from detailed areal studies of ground-water systems so as to improve knowledge of the aquifer systems and their responses to stress.

RESULTS--Continuous monitoring of barometric pressure, precipitation, and water levels in two wells, and monthly monitoring of water levels in 14 wells began in September 1993 at the site of the former Hallam Nuclear Power Facility. Water-level data for the 1992 calendar year were evaluated, analyzed, and published in the cooperative State report summarizing water-level changes in Nebraska. Selected ground-water-level data also were published in "Water Resources Data for Nebraska, Water Year 1992."

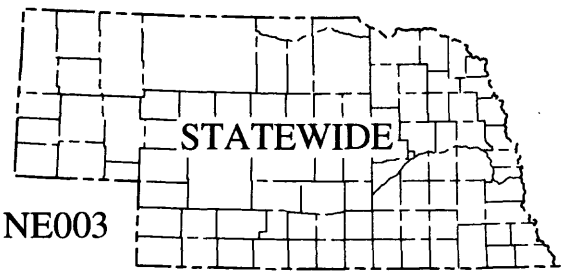
PLANS FOR FISCAL YEAR 1994--Installation of 11 new water-level recorder wells and 2 additional real-time wells is planned at the Lincoln Water Systems Ashland well field. Continue water-level monitoring with the existing ground-water observation-well network. Continue updating the ground-water-level data base. Prepare State-published report summarizing water-level changes for 1993 calendar year. Publish 1993 water year ground-water-level data in "Water Resources Data for Nebraska, Water Year 1993."

Collection of Water-Quality Data (NE-003)

Timeframe: Continuous since 1943

Project leader: Carol G. Hoy

Cooperating agencies: Nebraska Natural Resources Commission; Nebraska Department of Environmental Quality; U.S. Bureau of Reclamation; and Lower Platte North NRD



NEED FOR STUDY--Water-resources planning and water-quality assessment require a nationwide base of relatively standardized information. For appropriate planning and realistic assessment of the water resources, the chemical and physical quality of the rivers, streams, lakes, and reservoirs, as well as major ground-water systems, should be defined and monitored.

OBJECTIVES--To provide a national data base of water-quality information for State, local, and Federal planning and action programs. Primary objectives of the network are to depict areal variability of streamflow and water-quality conditions nationwide on a year-by-year basis and to detect and assess long-term changes in water quality.

APPROACH--Obtain samples for water-quality analysis using established protocols and techniques from a network of stations to provide for broad Federal planning and action programs and to provide data for local management of the water resources of Nebraska.

RESULTS--Records of the physical, chemical, microbiological, or radiochemical quality of water were obtained from 20 stream sites and 250 wells. Records were evaluated, updated, and published in "Water Resources Data for Nebraska, Water Year 1992." Ground water was sampled in the O'Neill and Prairie Bend units in 1993 as part of the Missouri River Basin Program. Ground- and surface-water samples collected by the Lower Platte North NRD were analyzed.

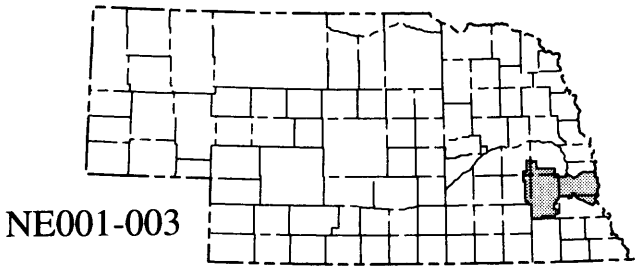
PLANS FOR FISCAL YEAR 1994--Water from 22 stream sites will be sampled under U.S. Geological Survey NASQAN, Benchmark, Missouri River Basin, and National Research programs. Samples of ground water will be collected from an established network of wells in the Big Blue unit. Results of water-quality analyses will be published in "Water Resources Data for Nebraska, Water Year 1993."

Monitoring Runoff and Nonpoint-Source Chemicals (NE-001, NE-003)

Timeframe: October 1993 - present

Project leaders: Glenn B. Engel, Fran J. Jelinek

Cooperating agency: Lower Platte North NRD



NEED FOR STUDY--Water-resources planning requires information on nonpoint sources of contamination. There is an increasing demand for domestic and recreational uses for surface water, and information is needed on present water-quality conditions to define improvements due to changes in agricultural practices.

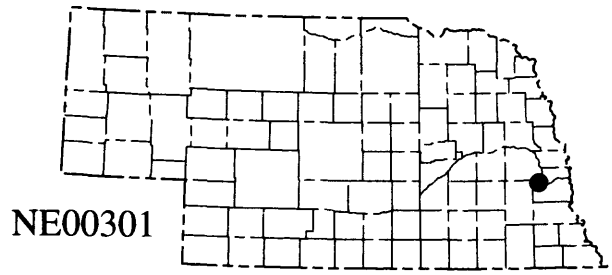
OBJECTIVES--(1) To obtain baseline water-quality data at a number of sites in areas of changing agricultural practices and in areas where no change in practices is expected. (2) To develop a data base of water quality from which to evaluate changes in a basin.

APPROACH--Install surface-water continuous-record gages to define discharge. Obtain samples from runoff and base flow to determine present water-quality conditions. Stations will be located at sites with changing agricultural practices and downstream from structures, such as sediment traps. Other stations will be located at sites where no such changes are expected to provide a water-quality baseline. Automatic samplers will be installed to obtain water-quality samples during high flows.

RESULTS--Equipment was purchased in 1993. NRD personnel began sampling at stream sites and lake sites. Pesticide samples were sent to the U.S. Geological Survey National Water-Quality Laboratory in Arvada, Colorado.

PLANS FOR FISCAL YEAR 1994--Install gages and automatic samplers at sites in the Cottonwood Creek Basin and, possibly, at additional sites in the Sand Creek Basin. Collect water samples at varying discharges and analyze for pesticides, nutrients, and sediment. Install automatic sampler at downstream site on Wahoo Creek.

Ground-Water and Water-Quality Monitoring at the Lincoln Municipal Well Fields (NE-00301)



Timeframe: Continuous since 1990

Project leaders: Ingrid M. Verstraeten and Gregory V. Steele

Cooperating agency: City of Lincoln

NEED FOR STUDY--Long-term water-level records are needed to evaluate stress variations on the ground-water systems near and including the City of Lincoln well fields. The data base is needed to measure the long-term effects of ground-water withdrawals and to assist in any projection of future supplies. In addition, monitoring the water quality of nine monitoring wells quarterly or annually is needed to assist the City of Lincoln in the management of the Ashland water supply.

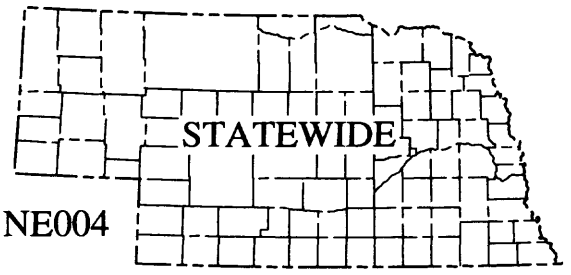
OBJECTIVES--(1) To collect and evaluate present and historical ground-water-level data; (2) to provide a data base for use in future projections of water supply; and (3) to provide a water-quality data base.

APPROACH--To maintain the observation-well network and input historical data and data provided by the cooperator into the U.S. Geological Survey data base. Analyze these and other available data. Collect water samples from nine monitoring wells located near the Platte River or located downgradient from the Mead Superfund Site.

RESULTS--Three wells at the Lincoln Water Systems Ashland well field were upgraded with real-time recorders. Ground-water-level and water-quality monitoring were continued.

PLANS FOR FISCAL YEAR 1994--Fiscal year 1993 water-quality data will be discussed with and provided to the cooperator in fiscal year 1994. Annual sampling of the nine monitoring wells will continue in fiscal year 1994.

Sediment-Data Program (NE-004)



Timeframe: Continuous since 1946

Project leaders: Carol G. Hoy and Glenn B. Engel

Cooperating agency: U.S. Geological Survey
Federal program

NEED FOR STUDY--Sediment concentrations and discharges in rivers and streams need to be defined and monitored to make a comprehensive water-quality assessment of the Nation's water resources, to define erosion, transport, and deposition characteristics, and to define physical characteristics of the sediment itself.

OBJECTIVES--To provide a national data base of standardized sediment information for use in Federal and State planning and action programs and to provide data for Federal management of interstate and international waters.

APPROACH--Establish and operate a network of sediment-collection sites to provide spatial and temporal averages and trends in sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams in Nebraska.

RESULTS--Data were collected either bimonthly or quarterly at eight sediment-collection sites, and average daily concentrations and loads were computed at one site. Data were published in "Water Resources Data for Nebraska, Water Year 1992."

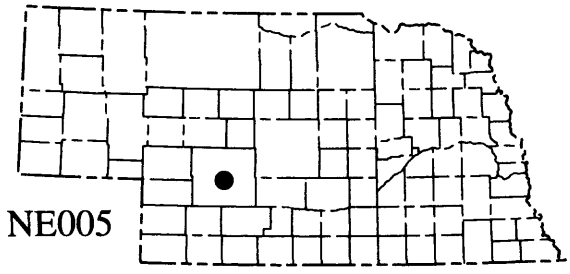
PLANS FOR FISCAL YEAR 1994--Data will be collected either bimonthly or quarterly at 13 sites. Collection of daily sediment data for one site was discontinued. The data will be published in "Water Resources Data for Nebraska, Water Year 1993."

Monitoring Atmospheric Precipitation for National Trends Network (NE-005)

Timeframe: Continuous since August 1985

Project leader: Glenn B. Engel

Cooperating agencies: U.S. Geological Survey Federal program and University of Nebraska-Lincoln, Conservation and Survey Division



NEED FOR STUDY--There is a potential for damage to the environment from acid rain, and improved knowledge of precipitation chemistry and resulting effects on the environment are necessary to help avert future environmental damage.

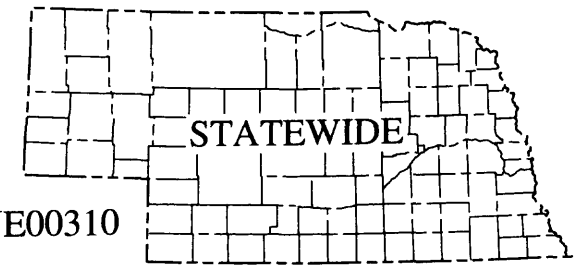
OBJECTIVES--The objectives of the National Trends Network (NTN) are to establish a record that will allow the detection of trends in the chemical composition of atmospheric deposition and to improve understanding of the sources, movement, and transformation of materials contributing to or associated with acidic atmospheric deposition in the United States and its effects on the environment.

APPROACH--Install an atmospheric-deposition monitoring station at the University of Nebraska West-Central Research and Extension Center near North Platte, Nebraska. Provide training for local station operators. Visit the station on a quarterly basis to evaluate operator efficiency and inspect the facility. Precipitation samples are collected weekly by Conservation and Survey Division personnel and analyzed for specific conductance, pH, and major ions at the Illinois State Water Survey Laboratory in Champaign, Illinois.

RESULTS--The precipitation collector for atmospheric-deposition analysis was operated at the University of Nebraska Agricultural Station near North Platte, Nebraska. Samples were collected by Conservation and Survey Division personnel and analyzed at the Illinois State Water Survey Laboratory in Champaign, Illinois. Results are published annually by the National Atmospheric Deposition Program in "Precipitation Chemistry of the United States."

PLANS FOR FISCAL YEAR 1994--Sample collection will continue on a weekly basis. Quality control will be maintained by contacts with the station operator, by monitoring of sample completeness, and by periodic checks of equipment.

National Water Summary, 1992-93: Hydrologic Events and Wetland Resources (NE-00310)



Timeframe: Continuous

Project leader: Jill D. Frankforter

Cooperating agency: U.S. Geological Survey
Federal program

NEED FOR STUDY--The National Water Summary (NWS) for 1992-93 is the eighth in a series of reports that describe an aspect of the water resources in each State. Information on conditions and trends in wetlands will be presented in the 1992-93 summary.

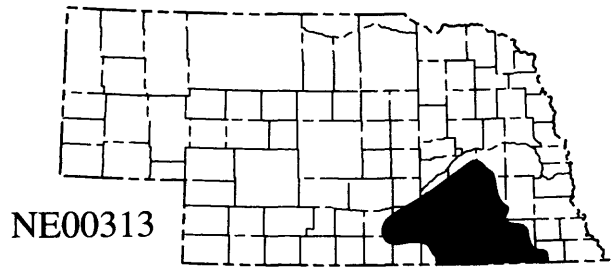
OBJECTIVES--National Water Summary reports are intended for use by Congressional, Federal, State, and local agency personnel, and the general public. Specific objectives for the 1992-93 report are to: (1) provide a brief account of the types of wetlands that are present in the State, their distribution, and hydrology; (2) discuss the management and water-quality trends of wetlands; and (3) compile information on wetlands from recent publications as well as unpublished information from other Federal, State, and local agencies, and from private organizations.

APPROACH--Gather all available publications and other information currently available about wetlands through research and contacts with other Federal and State agencies. This information will be consolidated and combined with illustrations provided by the Cartographic and Publications Program of the USGS. The summary will be based on the compiled information.

RESULTS--Various agencies and private organizations were contacted, and relevant data were collected. Data were compiled, and the summary for Nebraska was written.

PLANS FOR FISCAL YEAR 1994--Review will be completed. The Nebraska summary, along with the other State summaries, will be published in U.S. Geological Survey Water-Supply Paper 2425.

Herbicide Study--Blue River Basin (NE-00313)



Timeframe: September 1992-September 1994

Project leader: Jill D. Frankforter

Cooperating agencies: Nebraska Department of Environmental Quality

NEED FOR STUDY--Large concentrations of atrazine and other herbicides have been reported in the Big Blue River Basin in Nebraska. The Big Blue River is the largest downstream tributary of the Kansas River, contributing about 27 percent of the mean annual discharge during 1971-86. Water from the Kansas River is used in the public drinking-water supplies for the cities of Lawrence, Topeka, and Kansas City, Kansas. Compilation of the existing surface-water-quality data from the basin for atrazine and other select pesticides is needed to provide a foundation for future surface-water-quality studies within the Big Blue River Basin in Nebraska.

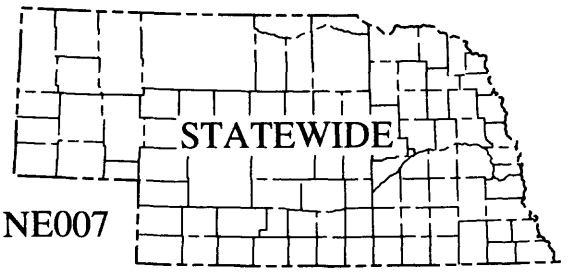
OBJECTIVES--The primary objective of this project is to compile a data report containing available surface-water-quality data for atrazine and other select herbicides within the Big Blue River Basin. A secondary objective is to evaluate additional surface-water-monitoring needs within the basin.

APPROACH--Available data from past studies within the Big Blue River Basin in Nebraska will be compiled. From these data, the number of detections of atrazine in the samples will be noted, as will the range of concentrations of the herbicide. The number of detections and concentrations of other pesticides frequently used within the basin also will be documented. Using these data, additional sites will be selected on the basis of the frequency of past detections, land-management practices, and location within the basin.

RESULTS--The data report, "Compilation of atrazine and selected herbicide data from previous surface-water-quality investigations within the Big Blue River Basin, Nebraska, 1983-92," has been completed and is currently in review. A project proposal for a 4-year cooperative project with the Nebraska Department of Environmental Quality also was completed and is currently in review.

PLANS FOR FISCAL YEAR 1994--Complete report review and publish report.

Water-Use Program (NE-007)



Timeframe: Continuous since 1965

Project leader: Jill D. Frankforter

Cooperating agencies: Nebraska Natural Resources Commission and Nebraska Department of Water Resources

NEED FOR STUDY--Water-use data are needed to provide the basis for natural resource assessment, regional and national policy formulation, specific problem analysis, and research activity. With the increasing demand for water for domestic, industrial, agricultural, and other uses, it is necessary to inventory and plan for the most beneficial use of the resource.

OBJECTIVES--The principal objective is to collect and compile water-use information for the State of Nebraska that meets both State and national needs. Additional objectives are to: (1) develop guidelines for data storage and retrieval, and for collecting and processing water-use data that will provide a means to achieve an appropriate level of quality assurance and quality control; and (2) prepare reports on water-use data by category for the 1990 calendar year and at 5-year intervals thereafter.

APPROACH--In cooperation with the Natural Resources Commission, information will be collected for national water-use categories and a report prepared at 5-year intervals. Selected data will be collected annually. Data will be entered into the U.S. Geological Survey National Water-Use Data System. Methods and techniques for collection, storage, and dissemination of water-use information will be improved.

RESULTS--Estimated water-use report for 1990 has been submitted for review.

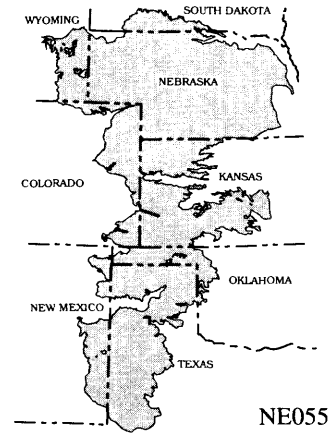
PLANS FOR FISCAL YEAR 1994--Interim data will be collected. Selected data-collection methods will be revised.

Monitoring Ground-Water Conditions and Water-Level Changes in the High Plains Aquifer Underlying Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming (NE-055)

Timeframe: Continuous since April 1988

Project leaders: Jack T. Dugan and Gregory V. Steele

Cooperating agencies: U.S. Geological Survey Federal program and the following NRD's: Central Platte; Lower, Middle, and Upper Republican; North Platte; South Platte, Upper Elkhorn; Upper Loup; and Upper Niobrara-White



NEED FOR STUDY--The High Plains aquifer underlies one of the major agricultural areas in the United States. About 30 percent of all ground water used for irrigation in the United States is pumped from the High Plains aquifer. The Omnibus Water Resources Development Act of 1986 (Public Law 99-662), which amended the Water Resources Act of 1984, added a Title III to the legislation that states that the U.S. Geological Survey, in cooperation with the States of the High Plains region, is authorized and directed to monitor the levels of the High Plains aquifer and to report annually to Congress. Congress recognized that accurate information on the conditions and changes in the aquifer is necessary to make sound management decisions concerning the use of water, to project future economic conditions, and to conduct hydrologic research pertaining to the High Plains.

OBJECTIVES--Nebraska District objectives for this program are: (1) as part of the cooperative program, to develop a monitoring-well network in Nebraska that allows for an adequate description of water-level conditions in the High Plains aquifer system; and (2) as part of the Federal program, to interpret and report on water-level conditions for the entire High Plains aquifer system.

APPROACH--(1) Review data from U.S. Geological Survey and local agency observation-well networks to determine if data are adequate for defining areal and temporal water-level changes in Nebraska. (2) Work in cooperation with local agencies to expand the U.S. Geological Survey's capability of reporting on changes in the High Plains aquifer system. (3) Compile and collate information on precipitation, land use, and water levels from the eight States in the High Plains region in order to analyze and describe annual water-level changes and water-level changes since 1980 in the High Plains aquifer and to report the results in an annual report.

RESULTS--Annual water-level data for Nebraska were compiled from the various Federal, State, and local agencies. Information on precipitation, land use, and water levels in the eight States within the entire High Plains region also were compiled. The 1988-89, 1989-90, and 1991 reports have been published. Information on precipitation, land use, and water levels in the eight States within the High Plains region for 1992 have been collected and analyzed. A draft of the 1992 report on water-level changes in the High Plains aquifer was completed and is in review.

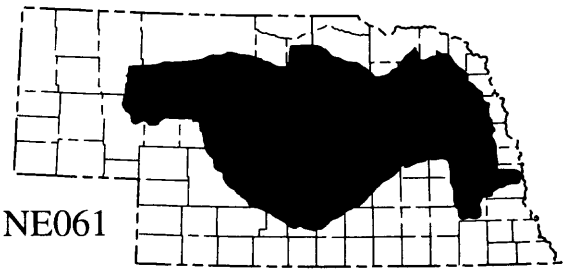
PLANS FOR FISCAL YEAR 1994--Complete review, revision, and publication of the 1992 report. Complete review, revision, and publication of the 1993 report.

National Water-Quality Assessment of the Central Nebraska Basins (NE-061)

Timeframe: October 1, 1990 -

Project leader: Thomas L. Huntzinger

Cooperating agency: U.S. Geological Survey
Federal program



NEED FOR STUDY--The Central Nebraska Basins, which include the Platte and Loup River drainages, are a significant resource to the area and to downstream users. Hydrologically, the area is an integrated stream and water-table aquifer system with reservoir control and pumpage for irrigation and public-water supplies. The area is primarily agricultural and has the potential for depletion of ground-water supplies and contamination from agricultural chemicals.

The Platte River is located within the Central Flyway for migratory birds and is a major stopover for waterfowl, including endangered species such as the whooping crane. There is concern that decreased streamflow and deteriorating water quality will have a detrimental effect on this wildlife resource.

OBJECTIVES--To assess the water-quality conditions in the Central Nebraska Basins through extensive use of existing data to: (1) provide a description of current water-quality conditions and trends, including sources of contamination, and (2) conceptually describe apparent relations between water-quality conditions and natural and human factors.

Additional analyses and data will: (1) verify the description of water-quality conditions, (2) define long-term trends in water quality, (3) reduce the uncertainty of the described water-quality conditions, and (4) increase knowledge of the relations between causative factors and water quality.

APPROACH--The water-quality assessment of the Central Nebraska Basins will include four distinct components that relate to a quantitative description of the water-quality conditions in the area. A thorough compilation, analysis, and interpretation of existing hydrologic data will be performed. The analysis will provide the basis for developing the strategy for obtaining specific additional hydrologic data that will be used to define areal and temporal distribution of water quality. Ancillary information will be obtained that will provide the most reliable information about current water-quality conditions and trends and their relation to natural and human factors. Hydrologic processes may be investigated in more detail in smaller areas on river reaches that relate to the solution of critical water-quality problems in the study area through analyses of available data or collection of new data.

RESULTS--Spring runoff samples were collected at 11 stream sites to determine the concentrations of pesticides, nutrients, and sediment. Monthly water-quality samples plus six additional samples over the range of stream discharges were collected at nine stream sites (fixed-station network). Fish community and benthic invertebrate and habitat data were collected at each of the nine stream sites sampled for water quality. Shallow water-quality monitoring wells were installed along a ground-water flow path in a wet meadow near the Platte River downgradient from cropland. A summary of available data was published. An article on the environmental setting was accepted for publication in the AWRA Water Resources Bulletin. A paper was published in the proceedings of an AWRA Symposium on soil water.

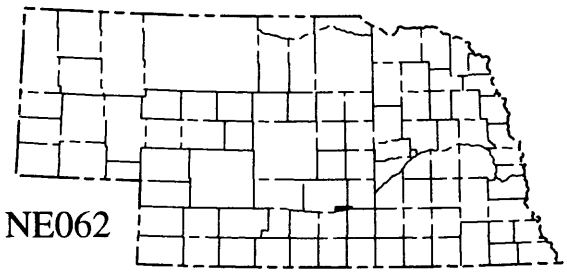
PLANS FOR FISCAL YEAR 1994--Complete monthly data collection at fixed-station network. Collect ground-water samples in Platte Valley. Complete biological data collection. Complete a low-flow synoptic survey at up to 30 stream sites.

Hydrogeology of the Management Systems Evaluation Area Site in Nebraska (NE-062)

Timeframe: October 1, 1990 - September 1, 1993

Project leader: John M. Kilpatrick

Cooperating agency: U.S. Geological Survey Federal program



NEED FOR STUDY--The Management Systems Evaluation Area (MSEA) projects, supported by the U.S. Department of Agriculture, are intended to demonstrate the effects of agricultural management practices on the quality of ground water. The principal research site for the Nebraska MSEA is a 560-acre tract of irrigated cropland located in the Platte River Valley near Shelton, Nebraska. Ground water in this part of the State has been contaminated from long-term use of agricultural chemicals. Because concentrations of agricultural chemicals in ground water represent a composite of past and present agricultural practices, any evaluation of the effectiveness of different water- and chemical-application techniques to be tested at the site will require an accurate and detailed description of the hydrogeologic framework in the vicinity of the site and quantification of the flow of water into, through, and out of the ground-water system.

OBJECTIVE--The objective of this study is to characterize the hydrogeologic system in the vicinity of the Nebraska MSEA site and its response to natural and human stresses. This information is essential to research efforts at the MSEA site to interpret the significance of changing concentrations of agricultural chemicals in the ground water and their relations to different irrigation-management systems.

APPROACH--The approach to be used for this study consists of three main components: (1) assembly and evaluation of existing hydrogeologic data; (2) collection of additional data needed to define the hydrogeologic system; and (3) interpretation of data, including an evaluation of the adequacy and accuracy of the data and synthesis of variables needed for defining the hydrogeologic system and hydrologic budget.

RESULTS--In fiscal year 1993, progress was made on several project tasks. A map report illustrating the changes in water levels in the vicinity of the MSEA site over time was drafted and is now in review. A detailed analysis of several well logs was completed and was used to generate three geologic sections and one structure contour map. This information and other gathered data were manipulated to form model data arrays used to construct a steady-state ground-water flow model of the area near the site. The PET and soil-water programs were used to generate stress simulations for the model. The ground-water flow model has been calibrated.

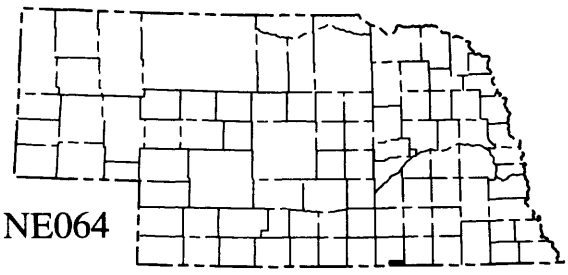
PLANS FOR FISCAL YEAR 1994--Continue to collect water-level, precipitation, pumpage, and land-use data. Conduct aquifer tests to determine hydrologic properties of the aquifer and any interrelations among aquifers. Begin preparation and calibration of a ground-water model for the study area. Complete reports.

Ground-Water and Sediment-Quality Monitoring for the Superior Special Protection Area, Superior, Nebraska (NE-064)

Timeframe: October 1, 1990 - September 1, 1994

Project leader: Abraham H. Chen

Cooperating agencies: Nebraska Department of Environmental Quality; Lower Republican and Little Blue NRD's; University of Nebraska-Lincoln, Conservation and Survey Division



NEED FOR STUDY--After conducting a ground-water-quality investigation at a 32-square-mile site in southern Nuckolls County during the spring and summer of 1988, the Nebraska Department of Environmental Quality concluded that ground-water contamination with nitrate was sufficiently widespread and concentrations were large enough to justify establishment of a Special Protection Area. A ground-water and sediment-quality monitoring program is important in evaluating the effects of land-management practices instituted as part of the Special Protection Area designation.

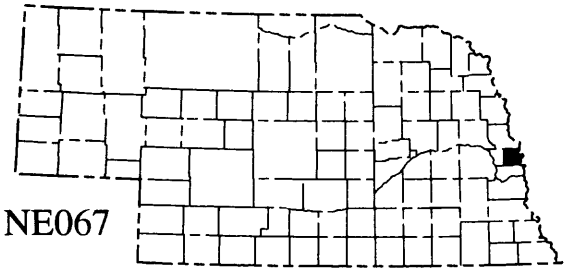
OBJECTIVES--(1) Identify acceptable sites for monitoring-well locations within the Special Protection Area; (2) determine the frequency with which ground-water samples should be collected and analyzed from these sites; (3) determine if nitrate concentrations in ground water are changing significantly in the study area and at what rate; (4) estimate the nitrate concentration of the unsaturated zone prior to fertilizer application at representative sites in the bottom and terrace lands; and (5) determine if nitrate concentrations in the unsaturated zone are changing significantly at representative sites in the study area and estimate the rate of change.

APPROACH--(1) About 16 sites will be selected, and an observation well will be installed in a suitable location at each site. (2) Water samples from each well will be collected bimonthly and analyzed for nitrate concentration. (3) A minimum of two representative sites will be selected for deep cores of the unsaturated zone, and sediment will be collected for nitrate analysis to determine the quantity and distribution of nitrate in the system. (4) Ground-water and sediment-nitrate data will be interpreted statistically.

RESULTS--All ground-water and sediment samples were collected and analyzed. Descriptions, exploratory, and nonparametric data analyses were performed with nitrate and bromide concentration data. Much of report is completed, with tables and figures in preparation at this time.

PLANS FOR FISCAL YEAR 1994--Complete report and submit for Director's approval.

Determination of Stormwater-Runoff Quality in Omaha, Nebraska (NE-067)



Timeframe: October 1, 1991 - September 30, 1994

Project leader: Abraham Chen

Cooperating agencies: City of Omaha, Papio-Missouri River NRD

NEED FOR STUDY--Section 402(p) of the Water-Quality Act of 1987 requires that municipalities with a population of 100,000 or greater obtain permits to control the quality of their storm runoff. Final rules published by the U.S. Environmental Protection Agency in November 1990 require that municipalities prepare permit applications to include technical information regarding the quantity and quality of stormwater-runoff discharges. In meeting these technical requirements, the U.S. Geological Survey, in cooperation with the City of Omaha and the Papio-Missouri River NRD, conducted an investigation to determine stormwater-runoff quantity and quality in Omaha, Nebraska, during fiscal years 1992-93.

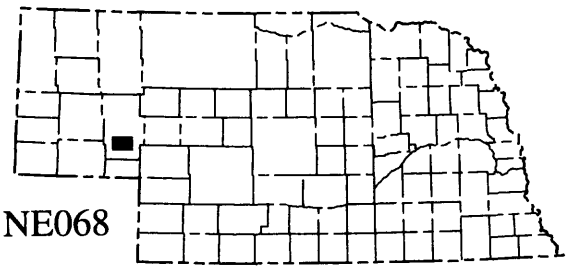
OBJECTIVES--(1) To characterize the quantity and physical, chemical, and bacteriological quality of stormwater in streams and channels draining five areas of specific land use in the City of Omaha. (2) To determine if the previously developed equations for predicting constituent loads and mean concentrations in urban stormwater can be used to accurately predict loads and concentrations for urban watersheds in the City of Omaha. (3) Compute estimates of annual and seasonal constituent loads and mean concentrations.

APPROACH--Five sites that are representative of land use within the City of Omaha will be selected. Discharge and water-quality data will be collected during six runoff periods at each of the five sites. Load estimates that are based on data collected at the five sites will be compared to load estimates generated by the regression equations. On the basis of this comparison, a method will be devised or selected to estimate loads for the entire study area.

RESULTS--Discharge and water-quality data were collected six times at the five sites, and site 6 was sampled three times during fiscal year 1993. All samples collected were analyzed by the U.S. Geological Survey National Water-Quality Laboratory in Arvada, Colo., for 144 pollutants and physical properties. Report preparation is underway.

PLANS FOR FISCAL YEAR 1994--Storm-runoff sample data will be analyzed by statistical techniques, such as descriptive, exploratory, and regression data analysis. Report will be published upon approval.

Agricultural Chemical Contamination of the North Platte River Alluvial Aquifer in Garden County, Nebraska (NE068)



Timeframe: October 1, 1992 - September 30, 1995

Project leader: Gregory V. Steele

Cooperating agency: North Platte NRD

NEED FOR STUDY--Evidence of nitrogen concentrations in ground water from the North Platte River Valley alluvium has been observed since the North Platte NRD started monitoring domestic wells in 1988. Additional work performed by the Conservation and Survey Division of the University of Nebraska-Lincoln in 1989 has shown an increase in nitrate concentrations in ground water in the study area and has demonstrated through nitrogen isotopic analyses that mineral fertilizers are the principal source of nitrogen in the ground water.

OBJECTIVES--(1) Define the hydrogeology of the study area to determine flow paths and times of travel at various locations. (2) Establish a network of observation wells at representative sites in Garden County's North Platte River Valley alluvium for the long-term monitoring of spatial distributions of concentrations of nitrate and other agriculturally related compounds. (3) Determine baseline concentrations of selected agricultural chemicals and naturally occurring elements in the ground water with which to assess the effects of different farming practices and to document other water-quality changes related to surface- and ground-water irrigation practices in the valley.

APPROACH--During the first year of the study, 10 sites for ground-water-quality monitoring wells, located within the North Platte River Valley alluvium, will be selected. At three sites, nests of two observation wells will be installed (one shallow and one deep); at each of the remaining seven sites, a single observation well, screened throughout most of the saturated zone, will be installed. Water samples from wells at these 10 water-quality sites and from the multilevel observation wells previously installed by the Conservation and Survey Division will be collected every 2 months for 2 years. Nitrate levels will be analyzed in all samples; major ions will be analyzed semiannually, and triazine herbicides will be screened annually.

The preliminary hydrologic characterization of the study area will require measurement of ground- and surface-water levels, mapping of the base of the North Platte River Valley alluvial deposits, mapping and classification of agricultural land use as it relates to chemical and water use, estimation of irrigation water use, and estimation of hydraulic conductivity and specific yield of the North Platte River Valley alluvial deposits.

Ground-water levels will be measured at approximately 90 wells during the spring of the first year and the spring and fall of the second year of the study. These data will be compared to stage heights from the U.S. Geological Survey streamflow-gaging stations on the North Platte River at Lisco and Lewellen and to the stage heights on the Platte River at Oshkosh and other crossings in the study area. The elevations at critical sites will be surveyed. A contour map of the base of the North Platte River Valley alluvial deposits will be produced to estimate the approximate saturated thickness of the deposits.

Logs for registered wells will be examined to estimate hydraulic properties and the thickness of the alluvial deposits. More refined estimates of aquifer transmissivity will be made through two single-well aquifer tests during April of the second year. Estimated hydraulic

conductivity and ranges of aquifer porosity will be combined with general flow-path delineations to estimate times of travel along specific flow paths.

RESULTS--Site selection was completed, and 14 observation wells were installed at 11 locations in May 1993. All sampling for fiscal year 1993 was completed. Observation of lithologic logs to determine aquifer properties has begun. Generation of maps of the alluvial boundaries and formulation of plans to install one water-level recorder at North Platte Garden County site 03 near Oshkosh, to record the trends in water levels prior to the pumping test (spring 1994), are in process.

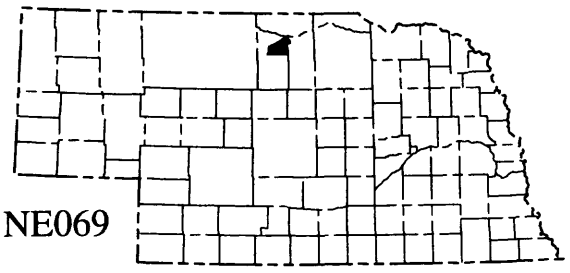
PLANS FOR FISCAL YEAR 1994--Perform a pump test to determine the hydraulic properties of the North Platte River alluvial aquifer.

Long Pine Creek Ground-Water-Quality Monitoring (NE-069)

Timeframe: October 1, 1992 - September 30, 1995

Project leader: A. Douglas Druliner

Cooperating agency: Nebraska Department of Environmental Quality



NEED FOR STUDY--The Long Pine Creek watershed was selected as a site for the Rural Clean Water Project (RCWP) in 1981 because of concentrations of agricultural chemicals in surface and ground water and large sediment loads in streams. The RCWP provided cost sharing to design and implement best-management practices within the watershed to control nonpoint-source contamination of surface and ground water. Many wells targeted for sampling, however, were not accessible from one year to the next, so water-quality samples often were collected from substitute wells, which caused difficulties in determining trends in ground-water quality.

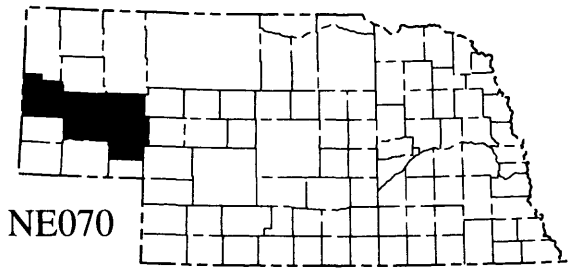
OBJECTIVES--(1) Establish a network of observation wells at representative sites in the Long Pine Creek watershed for long-term monitoring of spatial distribution of concentrations of nitrate and other agriculture-related compounds. (2) Determine seasonal variability of nitrate concentrations in ground water and determine optimal frequency for future ground-water sample collection from a network of observation wells. (3) Determine the relative age of ground water at different depths in the study area and estimate the vertical extent of the aquifer in which agriculture-related chemicals most likely will be found. (4) Provide training for local NRD personnel in the collection and handling of water-quality samples.

APPROACH--During the first year, the hydrogeology and land-use characteristics of the watershed were identified, monitoring wells sited and installed, and ground-water samples collected. Available land-use data were compiled and used in conjunction with the hydrogeologic data to select 12 sites for the installation of ground-water monitoring wells. Activities during the second year include continued water-quality sample collection and analysis, data interpretation, and report preparation. A report summarizing the results of these activities will be co-authored by the U.S. Geological Survey and the Nebraska Department of Environmental Quality.

RESULTS--Ten ground-water monitoring sites were selected, and 22 wells were drilled, cased, and developed. Ground-water samples were collected in August 1993 and analyzed for major ions, nutrients, selected herbicides, and selected trace elements. Preliminary results indicate that the water has small dissolved-solids concentrations, and silica is the principal constituent. Nitrate concentrations ranged from 0.93 to 29 milligrams per liter as nitrogen; the large concentrations were from shallow wells.

PLANS FOR FISCAL YEAR 1994--The approximate thickness and lateral extent of the five principal aquifers within the study area will be delineated. Water samples will be collected from 75 registered wells screened within the five principal aquifers and analyzed for nutrients and triazine herbicide screens. Water from 30 of these wells will be analyzed for major ions, selected trace elements, and radon. A report will be prepared and submitted for review.

Reconnaissance of the Surface-Water Quality of the North Platte Natural Resources District, Western Nebraska (NE-070)



Timeframe: October 1992-September 1996

Project leader: Gregory V. Steele

Cooperating agency: North Platte NRD

NEED FOR STUDY--No comprehensive study addressing the quality of surface-water systems in the North Platte NRD has been done in approximately 30 years. Thus, current chemical compositions of water in the river and canal systems are largely unknown. Surface-water quality is a concern because this system is hydraulically connected to the alluvial aquifers used for domestic, municipal, industrial, and irrigation supplies in the NRD.

OBJECTIVES--The study will be conducted in two phases. Phase I will consist of a reconnaissance-level effort to define the regional occurrence and dissolved major ions, dissolved nutrients, dissolved trace elements, dissolved uranium, selected dissolved herbicides, and distribution of bacteria. Phase II will consist of an in-depth process-oriented study that will be designed on the basis of the results of Phase I.

The principal objectives of Phase I are to characterize the surface-water quality at selected sites within the study area and to determine whether changes in the surface-water quality occur prior, during, or at the conclusion of the irrigation season. Long-term objectives of the study are to develop an understanding of the temporal distribution and sources of the constituents listed below. The specific objectives of Phase I are to: (1) determine the occurrence and concentrations of dissolved major ions, dissolved nutrients, dissolved trace elements, dissolved uranium, selected dissolved herbicides, and concentrations of bacteria in the surface water at representative sites of the principal rivers and canals; (2) examine the relations between the concentrations of these constituents and the hydrology, land use, and associated chemical and land-management practices of the study area; (3) establish a baseline of surface-water-quality conditions for future monitoring programs; and (4) generate a preliminary conceptual model of water-quality interactions within the surface-water system to be used in the design of Phase II.

APPROACH--Water samples will be collected near active streamflow-gaging stations prior to the irrigation season, shortly after the beginning of the irrigation season, and near the conclusion of the irrigation season. At each site, the samples will be composited in a large polytetrafluoroethylene churn splitter. Specific conductance, pH, temperature, and dissolved oxygen will be measured onsite. All discharge values will be obtained from established rating curves. At those sites where the samples will be collected in the centroid of flow, specific conductance and temperature will be measured to ensure that the water is adequately mixed.

Herbicide samples will be qualitatively analyzed by immunoassay for triazine and chlorophenoxy-acid herbicides in the Nebraska District office. If triazine herbicides are detected with this technique, the samples will be analyzed by the U.S. Geological Survey National Water-Quality Laboratory in Arvada, Colo., using quantitative gas-chromatography, mass-spectrometry analyses for triazine and acentanilide herbicides. Similarly, if chlorophenoxy-acid herbicides are detected, the samples also will be quantitatively analyzed by the National Water-Quality Laboratory. Quality assurance will consist of equipment blanks and duplicate samples collected at one site. A preliminary

interpretation of the results will serve as a basis for the design of Phase II. This preliminary interpretation will consist of comparisons of data by site and by date.

RESULTS--Eight Phase-I sampling sites were selected and sampled in early May 1993. All eight sites were resampled in June and September (correlating with the beginning and end of the irrigation season). Some preliminary data have been received, and these data were analyzed beginning in October.

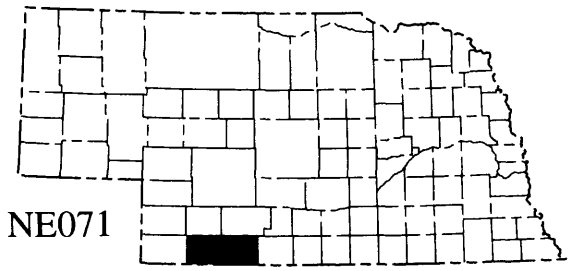
PLANS FOR FISCAL YEAR 1994--Water-quality data collected in Phase I will be analyzed. The analyses will help determine baseline concentrations and occurrence of the constituents that were sampled. Moreover, the analysis will help generate a conceptual model of surface-water quality to aid in the design of Phase II. The design of Phase II will be completed along with a journal article to be submitted to Water Resources Bulletin.

Monitoring Nitrate Concentrations in Ground Water and Soils in the Unsaturated Zone for the Hitchcock and Red Willow Counties Special Protection Area (NE-071)

Timeframe: October 1, 1992 - September 30, 1996

Project leader: Gregory V. Steele

Cooperating agency: Middle Republican NRD



NEED FOR STUDY--As a result of the occurrence of nitrate levels greater than 10 milligrams per liter in the ground water of the Republican River, Frenchman River, and Beaver Creek alluvium, the Nebraska Department of Environmental Quality requested a Special Protection Area (SPA) be created. The area, covering much of Red Willow and Hitchcock Counties, was designated a Special Protection Area in 1991. The Middle Republican NRD now must devise a ground-water-monitoring network that will identify the spatial and temporal trends in ground-water nitrate concentrations.

OBJECTIVES--(1) Identify acceptable sites for monitoring-well locations within the SPA. (2) Determine seasonal and vertical variations in ground-water nitrate concentrations and determine optimal times for network monitoring. (3) Determine nitrogen content of unsaturated zone prior to fertilizer application to serve as a baseline for later estimates in comparing the rate of nitrogen movement through the unsaturated zone. (4) Make preliminary estimates of the potential contribution of irrigation canal water and irrigation runoff to nitrate concentrations in ground water.

APPROACH--(1) Eighty sites for ground-water-quality monitoring will be sampled once per year for 2 years for nitrate concentrations. (2) Five nests of observation wells will be sampled monthly for 2 years for nitrate and major ion concentrations. (3) Six surface-water sampling sites within the canal system and the Republican River will be sampled for nitrate concentrations. (4) Deep soil cores will be analyzed for nitrate concentrations.

RESULTS--Assembled and evaluated all available data. Reviewed and evaluated published and unpublished reports. Selected 80 monitoring wells and obtained permission to sample during fiscal year 1994. Selected sites for multilevel wells for monthly sampling, installed wells, and initiated a 2-year sampling program. Developed a geographic-information-system base map of the study area. Prepared an outline of the final report and began preparation of selected parts of the report.

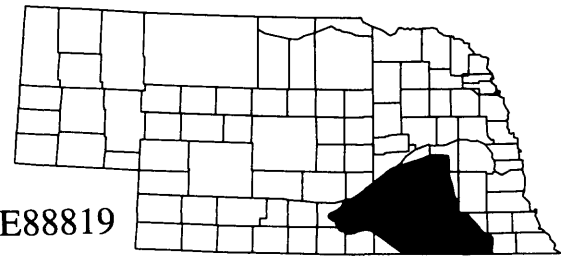
PLANS FOR FISCAL YEAR 1994--Monthly sampling of well nests will continue, sampling of the 80-well network will be done during the 1994 irrigation season, and deep soil cores will be collected at selected sites during the spring of 1994 (prior to application of fertilizers) and the fall of 1994 (after crops have been harvested). Work will continue on the preparation of selected parts of the final report.

Saturated and Unsaturated Zone Nonpoint-Source Monitoring Program in the Upper Big Blue Natural Resources District, Central Nebraska (NE-88819)

Timeframe: October 1993-September 1998

Project leader: Ingrid M. Verstraeten

Cooperating agency: Upper Big Blue NRD



NEED FOR STUDY--The Nebraska Department of Environmental Quality (NDEQ) conducted a water-quality investigation in the Upper Big Blue NRD from 1989 through 1991 to determine whether the area required Special Protection Area designation. On September 23, 1993, the NDEQ declared the Upper Big Blue NRD a Special Protection Area as numerous elevated nitrate concentrations were detected during the ground-water-quality study. A ground-water-quality monitoring program is needed to identify the spatial and temporal variability of nitrate concentrations in ground water with emphasis on the shallow aquifer system and to assess the presence of nitrogen concentrations in the unsaturated zone to aid in developing long-term best-management practices.

OBJECTIVES--(1) Evaluate the principal aquifer systems susceptible to nonpoint-source contamination on the basis of existing land-use, soil, geological, and hydrological information. (2) Identify acceptable monitoring sites and depths that effectively allow evaluation of nitrogen concentrations in the subsurface through time. (3) Identify frequency and optimal timeframes with which ground-water samples should be collected and analyzed. (4) Estimate nitrogen species concentrations in the unsaturated zone prior to fertilizer application at representative sites.

APPROACH--During the first year, an evaluation of soils, land use, geology, and hydrology will be conducted through use of a geographic information system, with emphasis on hydrogeology based on existing information. The existing monitoring network will be evaluated, and suitable sites for subsurface nitrogen monitoring will be selected. In addition, locations of approximately eight well nests will be selected and the wells constructed with dedicated pumps. During the second and third years, ground-water samples will be collected in late spring or summer, water levels will be measured, and ground-water samples will be collected monthly from the well nests. Ground-water samples will be analyzed for nitrate and physical properties. During the third year, deep cores of the unsaturated zone will be collected in triplicate from sites located near the well nest. Subsamples will be analyzed for nitrogen species. During the fourth year, data will be statistically analyzed, and a report will be written and submitted to the Upper Big Blue NRD. Review, revision, and publication of the report will be completed during the fifth year.

RESULTS--New investigation.

PLANS FOR FISCAL YEAR 1994--An evaluation of soils, land use, geology, and hydrology will be conducted through use of a geographic information system, with emphasis on hydrogeology based on existing information. The existing monitoring network will be evaluated, and suitable sites for subsurface nitrogen monitoring will be selected.

PROJECTS COMPLETE EXCEPT REPORT

The following is a list of projects that have been completed, but manuscripts have not yet received Director's approval or an assigned report number. Descriptions of these projects can be found in U.S. Geological Survey Open-File Report 92-633 (Fitzpatrick and McKinney, 1992).

- NE-00308: O'Neill Ground-water recharge: Water-quality investigation.

- NE-063: Reconnaissance of the ground-water quality in the North Platte Natural Resources District, western Nebraska, June-July, 1991.

- NE-057: Water-resources evaluation of the Omaha, Winnebago, and Santee Indian Reservations, Nebraska.

- NE-058: Simulated response to stress of the High Plains aquifer in the Upper Republican Natural Resources District, Nebraska.

- NE-066: Reconnaissance of the ground-water quality in the Papio-Missouri River Natural Resources District, eastern Nebraska, July through September 1992.

SOURCES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS AND INFORMATION

Books

Current U.S. Geological Survey reports are listed in a pamphlet entitled "New Publications of the Geological Survey." The pamphlet, issued monthly, is free on request to the Mailing List Unit, U.S. Geological Survey, 582 National Center, Reston, VA 22092. Prepayment for books generally is required, with checks or money orders payable to "Department of the Interior-USGS."

Professional papers, bulletins, water-supply papers, techniques of water-resources investigations, circulars, and publications of general interest, such as leaflets, pamphlets, and booklets, are available from the U.S. Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, MS 517, Denver Federal Center, Denver, CO 80225. Open-file reports and water-resources investigations reports are available for inspection at the District office of the U.S. Geological Survey in Lincoln, Nebraska, or the reports can be purchased in microfiche or paper copy from the Earth Science Information Center listed above.

The Geological Survey National Center maintains a library with an extensive Earth-sciences collection. Local libraries may obtain books, periodicals, and maps through interlibrary loan by writing to the U.S. Geological Survey Library, 950 National Center, Reston, VA 22092, telephone (703) 860-6671.

Records of streamflow, quality of water, and ground-water levels are available in a series of reports published annually for each State. For Nebraska, the report is entitled, "Water-Resources Data, Nebraska--Water Year 19__." Copies of the Nebraska report may be obtained by writing to the U.S. Geological Survey, 406 Federal Building, 100 Centennial Mall North, Lincoln, NE 68508.

Maps

Miscellaneous investigations maps, hydrologic investigations atlases, hydrologic unit maps, and topographic maps are available for sale from the Map Distribution Section, U.S. Geological Survey, Federal Center, Box 25286, Denver, CO 80225, telephone (303) 236-7477.

Flood-prone maps for selected areas of Nebraska can be obtained from the U.S. Geological Survey, 406 Federal Building, 100 Centennial Mall North, Lincoln, NE 68508.

Other Information Available

Hydrologic data stations maintained at selected locations throughout Nebraska make up a water-resources data network for obtaining records on stream discharge and stage, reservoir and lake storage, ground-water levels, and the quality of ground and surface water. The U.S. Geological Survey has both current and historical files of these data in WATSTORE (National Water Data Storage and Retrieval System). Data from these files are available in machine-readable form or in computerized tables, statistical analyses, and digital plots. These services or products can be obtained by contacting the U.S. Geological Survey, Nebraska District office.

NAWDEX, the National Water Data Exchange, was established to assist users of water data to identify, locate, and acquire needed data. It provides a nationwide service for indexing and describing the characteristics of data available throughout the Federal and non-Federal water-data community. NAWDEX maintains two data bases: (1) a Water-Data Sources Directory and (2) a Master Water-Data Index, which identifies and describes available water data. The U.S. Geological Survey, Nebraska District office, is a designated Local Assistance Center for searching for and accessing water data held by NAWDEX members. A directory of assistance centers and more detailed information about services can be obtained from the NAWDEX Program Office, Branch of Water Information Transfer. The NAWDEX headquarters address is National Water-Data Exchange, U.S. Geological Survey, 421 National Center, Reston, VA 22092, telephone (703) 648-5677.

Additional information about U.S. Geological Survey products is given in "A Guide to Obtaining U.S. Geological Survey Information," U.S. Geological Survey Circular 900, which is available at no charge from the Branch of Distribution, U.S. Geological Survey, Federal Center, Box 25286, Denver, CO 80225.

WATER-RESOURCES REPORTS RELEASED BY U.S. GEOLOGICAL SURVEY, NEBRASKA DISTRICT, 1985-94

Bartz, P.A., and Peckenpaugh, J.M., 1986, Hydrologic data for the south-central area, Nebraska: U.S. Geological Survey Open-File Report 86-246, 78 p.

Boohar, J.A., Hoy, C.G., and Ellis, M.J., 1989, Water resources data, Nebraska, 1988: U.S. Geological Survey Water-Data Report NE-88-1, 391 p.

_____1990, Water resources data, Nebraska, 1989: U.S. Geological Survey Water-Data Report NE-89-1, 429 p.

Boohar, J.A., Hoy, C.G., and Steele, G.V., 1991, Water resources data, Nebraska, 1990: U.S. Geological Survey Water-Data Report NE-90-1, 325 p.

_____1992, Water resources data, Nebraska, 1991: U.S. Geological Survey Water-Data Report NE-91-1, 354 p.

_____1993, Water resources data, Nebraska, 1992: U.S. Geological Survey Water-Data Report NE-92-1, 340 p.

Cady, R.E., and Peckenpaugh, J.M., 1985, Documentation of a Regional Aquifer Simulation Model, RAQSIM, and a description of support programs applied in the Twin Platte-Middle Republican study area, Nebraska: U.S. Geological Survey Water-Resources Investigations Report 85-4168, 239 p.

Chen, H.H., and Druliner, A.D., 1987, Nonpoint-source agricultural chemicals in ground water in Nebraska--Preliminary results for six areas of the High Plains aquifer: U.S. Geological Survey Water-Resources Investigations Report 86-4338, 68 p.

Dugan, J.T., 1985, Mass water-level measurements of fall 1984 in the Central Platte River Basin, Nebraska: U.S. Geological Survey Open-File Report 85-193, 22 p.

_____1986, Hydrologic characteristics of soils in parts of Arkansas, Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas: U.S. Geological Survey Hydrologic Investigations Atlas HA-678, 1 sheet, scale 1:500,000.

Dugan, J.T., Hobbs, R.D., and Ihm, L.A., 1990, Hydrologic characteristics of soils in the High Plains, Northern Great Plains, and Central Texas Carbonates regional aquifer systems: U.S. Geological Survey Hydrologic Investigations Atlas HA-714, 1 sheet, scale 1:3,168,000.

Dugan, J.T., and Peckenpaugh, J.M., 1985, Effects of climate, vegetation, and soils on consumptive water use and ground-water recharge to the Central Midwest regional aquifer system, mid-continent United States: U.S. Geological Survey Water-Resources Investigations Report 85-4236, 78 p.

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