Jean C. Prior

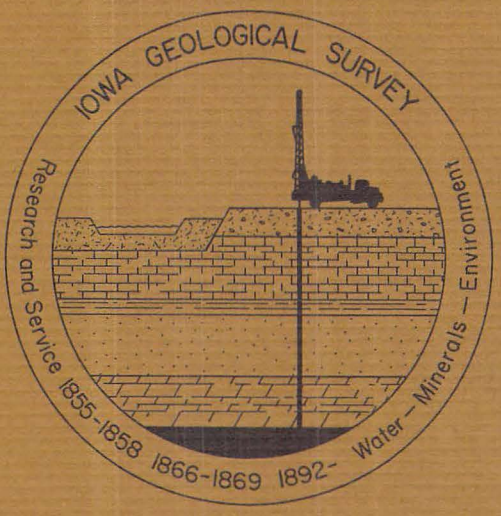
ANNUAL REPORT

of the

STATE GEOLOGIST

to the

GEOLOGICAL BOARD



Volumes 43-44
30 June 1973

STATE OF IOWA
IOWA GEOLOGICAL SURVEY
16 WEST JEFFERSON STREET
IOWA CITY, IOWA 52242
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Samuel J. Tuthill
Director and State Geologist

Orville J. Van Eck
Assistant State Geologist

September 6, 1973

The Honorable Robert D. Ray, Chairman
Geological Board of Iowa
State Capitol Building
Des Moines, Iowa

Dear Governor Ray,

Attached is the Annual Report of the State Geologist for the 1972-1973 fiscal year. The programs described in the Report were conducted by the Survey staff on an annual budget appropriated by the General Assembly of $495,104, plus a federal grant of $31,000, and a federal contract of $40,000. All ancillary assignments of Survey personnel such as the Task Force on Midwest Energy Requirements and Environmental Protection of the Midwestern Governor's Conference, the Governor's Advisory Committee on Fuel Supply, Iowa Conservancy District Task Force of the Department of Soil Conservation, etc., (see pages 11 and 11a) were accomplished within this budget.

The efforts of the staff of the Survey on behalf of the citizens of Iowa are best illustrated by the contents of this report. While this communication is entitled the Report of the State Geologist, it is more accurately the report of the people who serve you as members of the Iowa Geological Survey team.

It is with pride that I respectfully submit this report to you and the Geologic Board.

Respectfully yours,

Samuel J. Tuthill

Samuel J. Tuthill
Director and State Geologist

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Iowa Geological Survey

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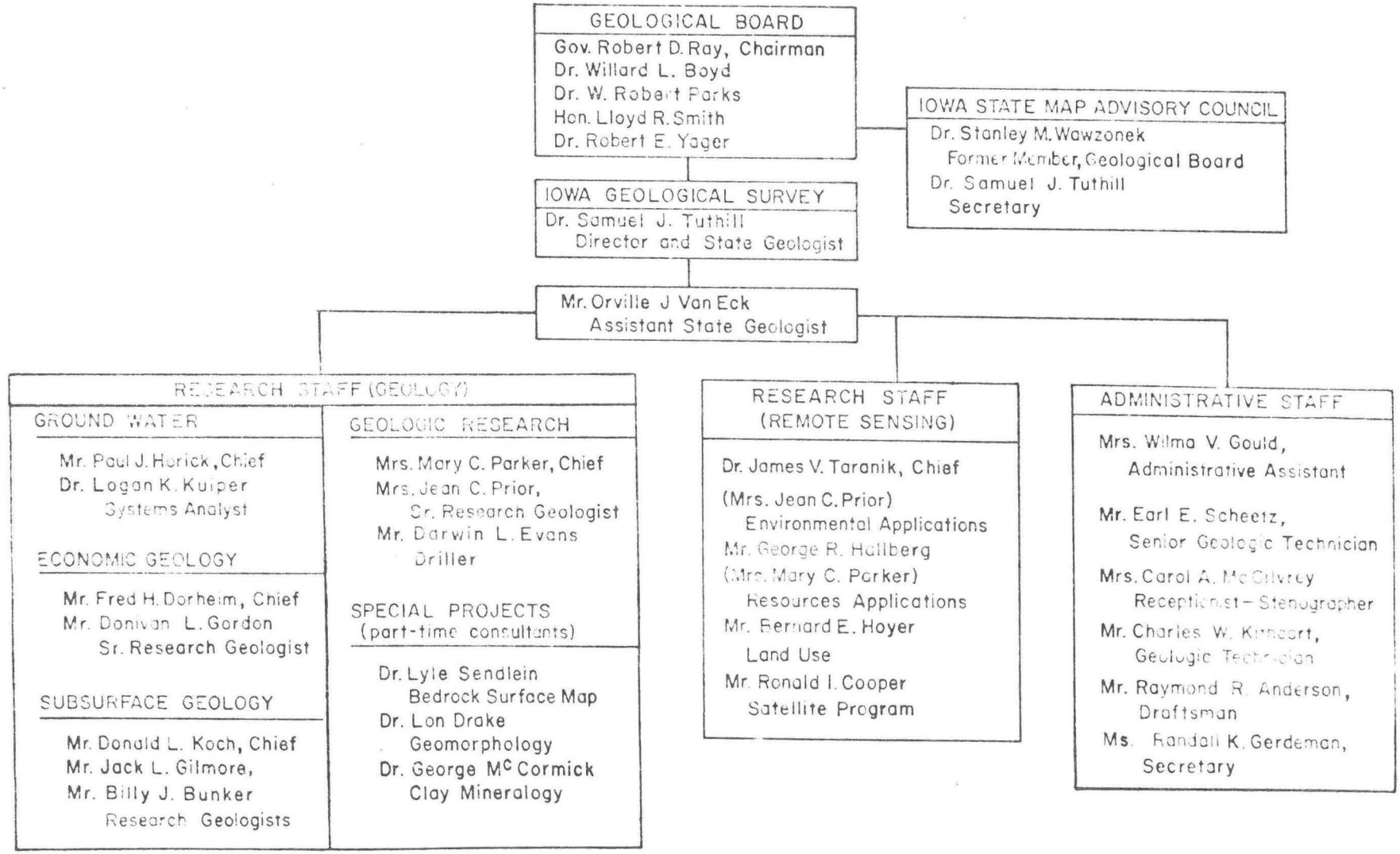
Figure 1 shows the table of organization for the Iowa Geological Survey for this date. Figure 2 shows the functional relationships of the Survey. During the past two years the Survey staff has accomplished the following major tasks:

I. GEOLOGICAL SURVEY PUBLICATIONS

1. Van Eck, O. J, 1971, Optimal Well Plugging Procedures: Pub. Info. Circ. No. 1, 7 p., 1 figure.
2. Parker, M. C., 1971, Resumé of Oil Exploration and Potential in Iowa: Pub. Info. Circ. No. 2, 11 p., 3 figures.
3. Parker, M. C., (Editor), 1972, Proceedings, Seminar in Applied Remote Sensing, May 8-12, 1972: Pub. Info Circ. No. 3, 176 p.
4. Tuthill, S. J., Gordon, D. L., and Dorheim, F. H., 1972, Hydrogeologic Considerations in Solid Waste Storage in Iowa: Pub. Info. Circ. No. 4, 57 p., 18 figures.
5. Dorheim, F. H. (Editor), 1972, Proceedings, Eighth Forum on Geology of Industrial Minerals: Pub. Info. Circ. No. 5, 195 p.

Figure 1. Staff Organization and Responsibility Assignment



IOWA GEOLOGICAL SURVEY

Research Cooperative Programs

U.S. Geological Survey
Groundwater (50/50)
U.S. Geological Survey
Surface Water (50/50)
National Aeronautics and
Space Administration
(40 IGS/60 US)
Dept. of the Interior, Office
of Saline Water
Environmental Protection
Agency

Consultation, Advisory, and Data Source Services

Iowa Department of Revenue
Iowa Water Well Drillers
Local and Regional Planning Commissions
Iowa Counties and Municipalities
Iowa Commerce Commission
Iowa Development Commission
Office for Planning and Programming
Iowa Air Pollution Control Commission
Iowa Water Pollution Control Commission
Iowa State Department of Health
Solid Waste Disposal Division
Municipal Water Supply
Iowa Chemical and Technology Review Board
Iowa State Hygienic Laboratory
Iowa Department of Justice
Iowa Natural Resources Council
Iowa Department of Soil Conservation
Iowa Agricultural Experiment Station
State Archaeologist
Iowa Highway Commission
Iowa Department of Mines and Minerals
Iowa Department of Agriculture
Iowa Preserves Board
Iowa Conservation Commission
The University of Iowa
Iowa State University
University of Northern Iowa
Iowa Department of Public Instruction
U.S. Department of Agriculture SCS
Iowa Citizens
Private Industry
Engineering Consultants

Participation in Other Agencies

Iowa Natural Resources Council
Iowa State Land Rehabilitation
Advisory Council
Iowa State Map Advisory Council
Iowa Conservation Education Council
Iowa City Chamber of Commerce
Environmental Concerns Committee
Dept. of Environmental Quality
Inter-Agency Resource Council
Dept. of Soil Conservation
Watershed Advisory Board
Conservancy District Task Force
U.S. Department of Agriculture
Iowa-Cedar Rivers Basin
Coordinating Committee

Fig. 2. Functional Relationships of the Iowa Geological Survey

6. Dorheim, F. H., Koch, D. L., and Tuthill, S. J., 1971, Environmental Geology and Land-Use Planning of the Sioux City Region, Iowa: Misc. Map Series 2, 4 p. text, 49 maps.

7. Hansen, R. E., 1973, Bedrock Topography of East-Central Iowa: 2 sheets.

8. Van Eck, O. J, 1973, Report of Preliminary Interpretation of Aeromagnetic Survey of Southern Iowa: 17 p, 2 maps.

9. Horick, P. J., Steinhilber, W. L., (in press), Mississippian Aquifer of Iowa: Misc. Map Series 3.

10. Hoyer, B. E., Taranik, J. V., 1972, Aerial Flood Mapping in Southwestern Iowa, a Preliminary Report: Prelim. Rept. No. 1, 11 p.

11. Tuthill, S. J., Hoyer, B. E., and Prior, J. C., 1972, The Mississippi River Overflight to Identify Sources of Warm Effluent: Prelim. Rept., 29 p.

12. Hallberg, G. R., Hoyer, B. E., 1973, Flood Inundation Mapping in Southwestern Iowa; a Preliminary Report, Analysis of ERTS-1 Imagery: Prelim. Rept. No. 2, 15 p.

II. SURVEY PUBLICATIONS IN FINAL PREPARATION

1. Hoyer, B. E., Wiitala, S., Hallberg, G. R., Steinhilber, W. L., Taranik, J. V., and Tuthill, S. J., 1973, Flood Inundation Mapping and Remote Sensing in Iowa: Pub. Info. Circ. No. 6.

2. Horick, P. J., Minerals of Iowa: Pub. Info. Circ. No. 7.

3. Taranik, J. V., Thermal Mapping of Hydrologic Systems in Iowa: Pub. Info. Circ. No. 8.

4. Cooper, R. I., Taranik, J. V., and Tuthill, S. J., Water and Land Planning in South-Central Iowa Using Remotely Sensed Data From ERTS-1: Pub. Info. Circ. No. 9.

III. PUBLISHED EXTRINSIC PUBLICATIONS

1. Kuiper, L., 1972, Groundwater Flow in an Inhomogeneous Aquifer: Water Resour. Res. 8 (3), 722.

2. Kuiper, L., 1972, Drawdown in a Finite Circular Aquifer with Constant Well Discharge: Water Resour. Res., 8 (3) 734.

3. Kuiper, L., 1973, Analytic Solution of Spacially Discretized Groundwater Flow Equations: Water Resour. Res.

4. Cavallaro, A. J., Van Eck, O. J, (in press), Preparation Characteristics and Desulfurization Potential of Iowa Coals: U. S. Bur. Mines.

5. Davis, L. C., Eshelman, R. E., and Prior, J. C., 1972, A Primary Mammoth Site with Associated Fauna in Pottawattamie County, Iowa: Iowa Acad. Sci. Proc., v. 79, no. 2, p. 62-65.

6. Prior, J. C., 1972, Energy Demands and Environmental Quality in Iowa: Iowa Econ. Index, 2d Quarter, Iowa Development Commission Research Division, p. 8-9.

7. Horick, P. J., 1973, Some Hydrologic Aspects of the Mississippian of Iowa: Iowa Acad. Sci. Proc., v. 80, no. 1.

8. Koch, D. L., 1973, Mississippian Stratigraphy of North-Central Iowa: Iowa Acad. Sci. Proc., v. 80, no. 1, 3 p.

9. Tuthill, S. J., Taranik, J. V., and Hoyer, B. E., 1973, Thermal Remote Sensing on the Mississippi River in Iowa: AIChE Symposium Series No. 129, v. 69, p. 391-400.

10. Tuthill, S. J.,and Taranik, J. V., 1972, Remote Sensing, A Tool for State Planning-Management in Iowa: Proc. 8th Internat. Symposium on Remote Sensing of the Environment, Env. Res. Inst. of Michigan, v. 1, p. 11-20.

11. Hoyer, B. E., and Taranik, J. V., 1972, Multispectral Photography and Floodplain Analysis in Iowa: Geol. Soc. Amer., Central Section v. 5, no. 4, 321 p.

12. Hallberg, G. R., Hoyer, B. E., and Rango, A., 1973, Application of ERTS-1 Imagery to Flood Inundation Mapping, in Symposium on Significant Results Obtained from ERTS-1, Goddard Space Flight Center, NASA.

13. Hallberg, G. R., Hoyer, B. E., and Rango, A., 1973, Application of ERTS-1 Imagery to Flood Inundation Mapping: in Significant Papers on ERTS-1, Plenary Session, Goddard Space Flight Center, NASA, in color.

14. Hallberg, G. R., and Morrison, R. B., 1973, ERTS-1 Satellite Study of Quaternary Landforms and Materials in the Midwest and Great Plains: A Progress Report (Abs.) Geol. Soc. Amer., Central Section, v. 5, no. 4, 320 p.

15. Morrison, R. B., and Hallberg, G. R., 1972, A Study of Quaternary Landforms and Materials in the Midwest and Great Plains, Progress Report to NASA, Natl. Tech. Info. Service, NASA-CR-129234, E72-10272, 11 p.

16. Morrison, R. B., and Hallberg, G. R., 1973, Mapping Quaternary Landforms and Deposits by Means of ERTS-1 Multispectral Imagery, in Symposium and Significant Results Obtained from ERTS-1, NASA.

17. Hardy, R. L., and Taranik, J. V., 1973, Getting it all Together in Earth Mapping Education; Photogrammetry, Geodesy, and Remote Sensing, an Interdisciplinary Approach: Amer. Soc. of Photogram., Proc. meeting in Operational Remote Sensing.

IV. EXTRINSIC REPORTS IN PRESS OR PREPARATION

1. Hallberg, G. R., 1972-73, A Study of Quaternary Landforms and Materials in the Great Plains and Midwest, NASA Type I and Type II Reports, 2-6 submitted to Natl. Tech. Info. Serv. for publication.

2. Taranik, J. V., and Tuthill, S. J., (in final preparation), Remote Sensing Data, A Basis for Monitoring Systems Design: in U. S. Env. Prot. Agcy. Proc. Las Vegas Conf. on Environmental Qual. Sensors.

3. Hallberg, G. R., Hoyer, B. E., and Taranik, J. V., (in final preparation), Multispectral Detection of Flood Inundation: Amer. Photogram., Photogram. Eng.

V. RESEARCH PROPOSALS PREPARED

1. Tuthill, S. J., and Taranik, J. V., 1972, A proposal to study the application of remotely sensed data from ERTS-A to the planning, management, and regulatory functions of 24 State and Federal agencies operating in Iowa: Submitted to NASA 15 Feb. 1972, 117 p., status-revision rejected.

2. Taranik, J. V., 1973, Land classification of South-Central Iowa from computer-enhanced images: Submitted to NASA 31 Jan. 1973, 77 p., status-pending evaluation, $71,000.00

3. Milligan, J., and Taranik, J. V., 1973, Interstate regional planning applications using ERTS-B imagery of the Midwest: Submitted to NASA 31 January 1973, 95 p., status-pending evaluation, $47,000.00

4. Tuthill, S. J., Taranik, J. V., and Hoyer, B. E., 1972, A proposal for resource development, Land and Water-Use Management, Six-County Region, South-Central Iowa: Submitted to EROS Program, U. S. Geological Survey, 21 July 1972, 42 p, status-grant contract awarded, $31,000.00.

5. Taranik, J. V., 1973, A proposal to develop a model for the prediction of optimal sites for industrial and agricultural development in Iowa: Submitted to Iowa Development Commission, 22 p., status: rejected.

VI. CONSULTATIVE, ADVISORY, AND DATA-SOURCE SERVICES

Well Predictions

Predictions for groundwater resources are made on request for groups or individuals. Most of them are presented in the form of letter reports, but some are telephoned reports. The requests come from a wide range of users and are summarized as follows:

	No.
Municipal	80
Industrial	50
Domestic	110
Housing and mobile home projects, schools	20
Recreational areas--parks, golf courses, etc.	25
Feedlots	15
Irrigation	10
Areal reports	15
Rural Water Districts	3
Hospitals	1
Other	10
Total	339

Well Logging

Drill cuttings from approximately 140 wells were logged for a total footage of 49,500 feet. Of this footage, about 22,000 feet were examined to determine depths to formation tops only. The remaining samples were logged in detail for each sample interval. The marked decrease in logging

compared with previous years reflects the loss of one subsurface stratigrapher through retirement, and a change in priority from groundwater data accumulation to groundwater data interpretation and application.

Casing Points

Drill cuttings from 19 municipal and industrial wells were examined to define casing points for the various municipal well contractors and/or engineers. The average depth of these wells is 1,900 feet. Verification of formation tops by the Geological Survey is relied upon to insure that drilling has reached the proper depth for placement of casing in wells.

Well Locations and Elevations

Locations and elevations were established for about 700 wells. It is necessary to field-check each well to obtain the correct location and ground-level elevation with respect to sea-level datum. Only then can the geological information from drill cuttings be used to generate maps that summarize data on groundwater availability, groundwater quality, thickness of rock formations, potential locations for the development of underground gas-storage facilities, land-use maps, and so forth.

Sanitary Landfills

The Geological Survey established geologic and hydrologic criteria to be included in the rules that govern sanitary landfill siting under the jurisdiction of the Solid Waste Division, Department of Environmental Quality. These criteria are designed to protect the water resources of the state. To assist the municipal

and county governmental agencies in the selection of sites that will best meet the geologic and hydrologic criteria, the Survey has furnished extant data to 40 such agencies, made 61 on-site inspections, and conducted earth-resistivity surveys on 45 potential sites (fig. 3).

In addition, all plans of proposed sanitary landfills that are submitted to the Department of Environmental Quality are reviewed by the Geological Survey to insure compliance with the rules designed to protect water resources. Since inception of the solid-waste disposal program 25 final and 15 intermediate plan reviews have been completed.

Oil and Gas Administrator

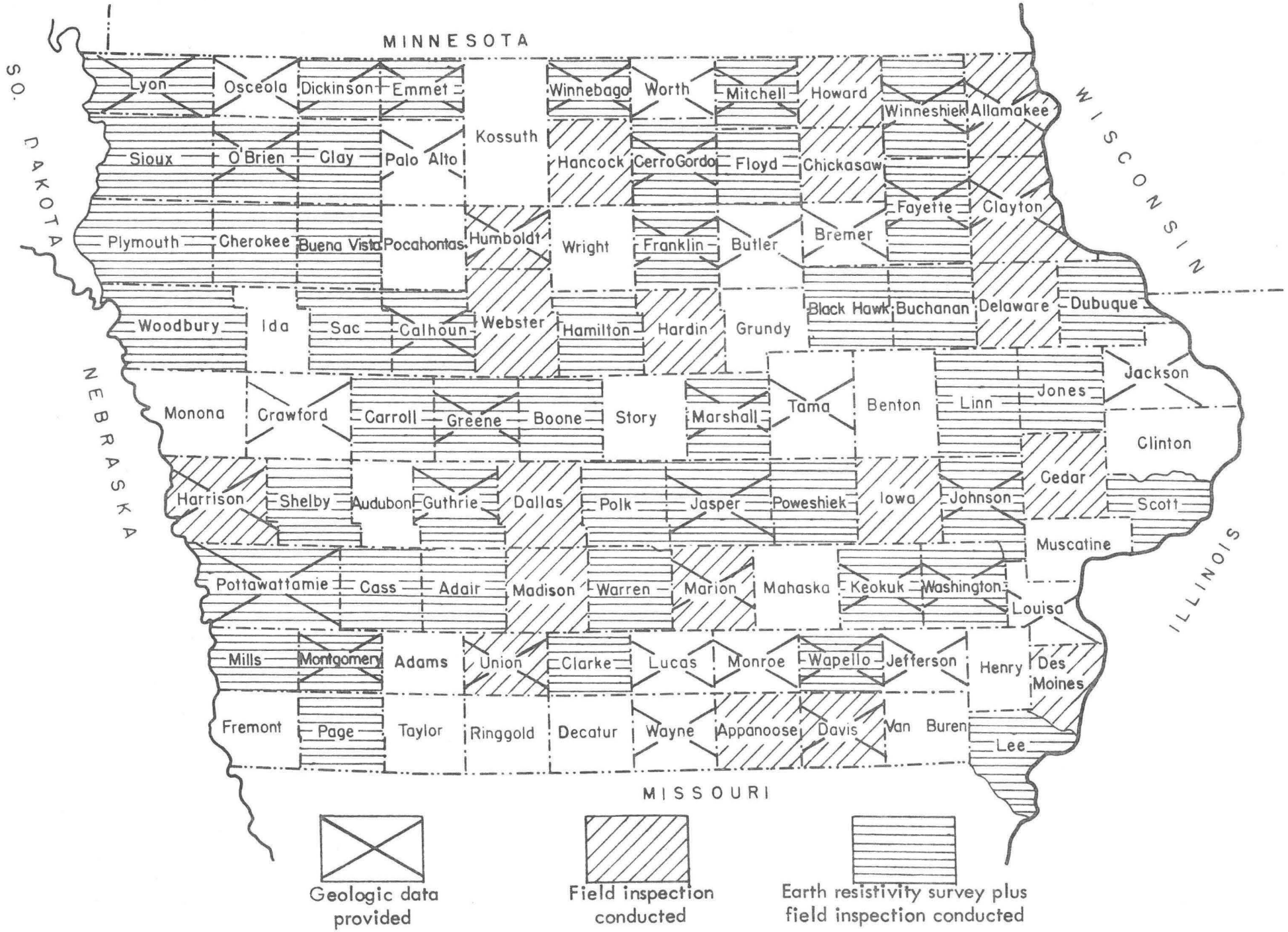
Three hundred and seven drilling permits were issued during the biennium. Thirty-nine of these were for gas injection/withdrawal wells associated with gas-storage projects, and 268 were for stratigraphic tests. No applications for permits for oil tests were made during this period.

The Geological Survey served as consultant to the Commerce Commission in establishing procedures to be followed by Northern Natural Gas Company in the abandonment of the Vincent gas-storage facility. The original land under lease for this facility when abandonment was begun was 12,373 acres. This area has been reduced to 2,240 acres as reported June, 1973.

Requests for Information

Each year the Survey receives a large number of requests for geologic and hydrologic information. The requests range from those from individuals questioning the possibility of an economically valuable geologic resource on their property to those from consulting engineering firms gathering regional geologic and hydrologic data relevant to nuclear power plant siting. The

Figure 3: Status of Assistance Provided for Sanitary Landfill Site Selection



manner in which the requested data is presented generally is dependent upon the nature and scope of the request.

Many of the requests from individuals are very localized in nature and to achieve the detail required to answer the question will require a special letter report. If there is a specific problem involved and sufficient extant data are not available to solve the problem, additional field observations are made by a staff geologist. Those requests that are much broader in nature can often be fulfilled by our publications.

As the geologic and hydrologic data bank becomes more completely automated, our ability to respond rapidly to requests for data has increased tremendously. For example, a number of the major mining and petroleum companies of the nation have requested all the data from our well-log files. Formerly this entailed a visit of several weeks' duration for one of the company employees to copy the data, in addition to the time of a Survey staff member to assist in making the data available. We are now able to supply such data in the form of computer print-outs within a week at a nominal cost to the user. Similarly, we are able to provide these data on a county basis to well drillers, engineers, planning agencies, and so forth, at a cost ranging from 5 to 10 dollars per county, dependent on the amount of data available for the particular county.

With the increased awareness by the general public of environmental problems and fuel shortages, there has been an increased demand for information. The Survey has responded to the demand with public addresses by staff members and numerous letter reports.

Consultative Contacts

The Survey is often called upon to provide consultative services to various State agencies, industries, and individuals. These services often involve on-site investigations in various parts of the state and interpretation of data. The following tabulation indicates the approximate number of contacts that fall within this category:

Agency or Group	No. Contacts
Iowa Natural Resources Council	120
Iowa Commerce Commission	25
Iowa State Department of Health	180
Iowa Conservation Commission	15
Iowa State Highway Commission	5
Office for Planning and Programming	40
Iowa Development Commission	20
Iowa Department of Justice	10
Iowa State Hygienic Laboratory	5
State Archeologist	10
Iowa Department of Soil Conservation	60
State University and Public Schools	100
Counties and Cities	250
Federal Agencies (FHA, etc.)	15
Engineering Consultants	150
Water Well Drillers	300
Industry	150
Individual Citizens	700
Total	2,155

Staff members have been appointed to a number of task force and liaison positions with other agencies

Task Force on Midwest Energy Requirements and Environmental Protection - S. J. Tuthill, Chairman

Iowa Map Advisory Council - S. J. Tuthill, Secretary

Iowa Natural Resources Council - S. J. Tuthill, Member and Administrator of Oil and Gas

Governor's Advisory Committee on Fuel Supply - S. J. Tuthill, Chairman

Solid Waste Disposal Commission, Department of Environmental Quality, S. J. Tuthill, Chairman

Iowa State Land Rehabilitation Advisory Council - S. J. Tuthill, Member

Inter-Agency Resource Council - S. J. Tuthill, Member

Field Advisory Committee, U. S. Department of Agriculture - O. J Van Eck, Member

Conservancy District Task Force, Department of Soil Conservation - O. J Van Eck, Member

Iowa Conservation Education Council - M. C. Parker and F. H. Dorheim, Members

Iowa City Chamber of Commerce Environmental Concerns Committee - J. C. Prior, Member

Iowa State Watershed Advisory Board, Department of Soil Conservation, J. C. Prior, Member

Air Quality Commission, Department of Environmental Quality - J. C. Prior, Liaison

Solid Waste Management Division, Department of Environmental Quality - D. Gordon, Liaison

Water Quality, Department of Environmental Quality - D. L. Koch, Liaison

VII. RESEARCH IN PROGRESS

1. Saline Water Study. A study of the economic feasibility of desalination systems for municipal water supplies in Iowa is being conducted under a grant provided by the U. S. Department of Interior Office of Saline Water and administered by the Geological Survey in conjunction with the Iowa State Department of Health and the Iowa Natural Resources Council.

The Office of Saline Water has defined saline water as any water containing more than 500 parts per million dissolved solids. In Iowa there are about 160 cities where the water being used for municipal supply exceeds 1,000 parts per million dissolved solids. On the basis of population, the chemical quality of the water now being used, the availability of an alternate source of water of adequate quality, and geographic location, the cities of Adair, Estherville, Grundy Center, Holstein, LeClaire, Leon, Oakland, Oxford, Sibley, and Washington were chosen as providing a representative cross section of those cities using water that contains 1,000 or more parts per million dissolved solids for a municipal water supply.

The study will determine the range of economic feasibility of various desalting techniques and also compare the costs of using the present highly mineralized water and whatever treatment is provided with the cost of using the much better quality water that can be provided through desalting methods. In addition to providing a method of improving the quality of existing municipal

supplies it is believed that desalting will be a water-resource management tool.

This study was recommended by the Water and Disposal System Committee of the Governor's Rural Policy Council. Completion of the study is scheduled for November 1973. Because the cities chosen for inclusion in the study represent a wide range of conditions it is expected that the final report will be applicable to any comparable city in the state.

2. Cold Water Cave. Geophysical reconnaissance using the earth resistivity technique to locate a suitable site for exploratory drilling was initiated on 17 December, 1971. Three test holes were drilled during the period 17 January — 22 February 1971. After completion of design and specifications for shaft construction, bids were let in May, and a contract was awarded in June, 1972. Construction on the shaft started on 8 July, and was completed on 29 August, 1972. Construction work on surface installations and procurement of special safety equipment continued into November.

Air samples collected from the cave on 30 August, 1972 contained CO_2 partial pressure of nearly 2.0%, compared with a CO_2 partial pressure of only 0.03% for normal air. The effect upon persons breathing high concentrations of CO_2 in the presence of adequate amounts of O_2 is to stimulate hyperventilation which, in turn, causes a physiological deficiency of CO_2. Personnel from the United States Bureau of Mines were consulted to formulate a rigorous safety program and to determine the testing equipment necessary to monitor composition of the cavern atmosphere. To date, CO_2 is the only potentially harmful gas

detected in the cave; the concentration has ranged from a high of 2.0% in August, 1972 to a low of 0.5% during the winter months, and has increased to a level of 1.5% as of this date. During the period when the concentration is 1.5% or below, and work performed in the cave is not vigorous, researchers are permitted to work without the use of auxiliary breathing apparatus.

Current research and ancillary functions are categorized as follows:

1. collection of air samples to monitor quality of cavern atmosphere; the air is tested at several stations during each entry.
2. collection and identification of extant aquatic and terrestrial biota.
3. collection and identification of Recent mammal and reptile remains.
4. collection of bulk sediments for extraction of vertebrate fossils.
5. collection of sediment cores for extraction of ancient spores and pollen.
6. collection of water samples to monitor water chemistry.
7. measurement of cavern stream discharge.
8. measurement of water temperature, and relative humidity.
9. photographic documentation.
10. experiments to observe rates of growth of speleothems.
11. collection of representative speleothems for isotopic dating.
12. tours by landowners that have provided access permission to those portions of the cavern system beneath their land.

3. Hydrology of Carbonate Aquifers of the Eastern Iowa Groundwater District.

The study site, dominantly within the western one-half of Linn County, has been selected because we believe it to satisfy the largest number of geologic, hydrologic, and socio-economic criteria. This area is typical of the conversion of landuse from rural-agricultural to urban-industrial. The regional geology imposes severe constraints upon the activities of man if the aquifers are to be protected from the pollutants that accompany the urbanization process. Completion of this study will result in invaluable data on flow systems in the unconsolidated sediments and in the bedrock aquifers, and on the physical and chemical behavior of the carbonate bedrock aquifers.

Test holes have been completed or partially completed at 20 locations; 19 of the locations are in Linn County and one is in northwestern Johnson County. The breakdown on samples recovered for specific uses is:

Type of sample	Sample use	Footage drilled
1. Cuttings from unconsolidated sediments.	Lithologies and stratigraphic control, Pleistocene deposits.	1,926
2. Cores of unconsolidated sediments.	Porosity and permeability tests.	34
3. Rock cuttings.	Stratigraphic control; structural mapping.	761
4. 2 1/8" diameter rock core.	Porosity and permeability tests; quantitative chemistry; petrology and diagenesis.	1,715
	Total	4,436 feet

Thin sections have been prepared from 98 samples of rock core. The thin sections will be studied with a petrographic microscope to determine diagenetic features that may effect variations in water chemistry and that may control the rate and direction of groundwater flow. Some of the drill holes will be constructed as multiple observation wells to monitor fluctuations of water levels in the various aquifers. Other drill holes will be completed as pumping wells for production tests.

Current data indicate that significantly larger volumes of water can be obtained at locations where bedrock highs exist, compared to locations where the bedrock is encountered at lower elevations. This observation can be extremely significant in the consideration of selection of sites for high production wells and sites for sanitary landfills.

4. Coal and Flue Gas Desulfurization. During the summer of 1972 the Geological Survey in cooperation with the U.S. Bureau of Mines sampled 10 of the 11 operating mines in the State for testing. In the testing, special emphasis was placed on physical desulfurization. The results indicated that the pyritic sulfur content could be reduced appreciably upon appropriate crushing and washing. A report entitled Preparation Characteristics and Desulfurization Potential of Iowa Coals (Cavallaro, A.J., and Van Eck, O. J) is to be published by the U.S. Bureau of Mines.

In a further effort to make the use of Iowa coal environmentally acceptable an agreement was entered into with the United States Environmental Protection Agency whereby E.P.A. would fund a study in Iowa at a level of $200,000 that has the following objectives:

1. To assess the feasibility of coal cleaning with respect to the degree and cost of reduction of sulfur emission.
2. To assess the sulfur control obtained and the cost effects resulting from burning cleaned coal and installing flue gas cleaning processes on existing plants.

The study will be conducted by an engineering consulting firm with the assistance of the Geological Survey acting as coordinator of data from the utilities and other state agencies.

5. Linn County Environmental Geology Project. Environmental planning is especially vital in areas that are undergoing rapid urban-industrial and agricultural growth with accompanying modification of rural regions. Linn County typifies such an area. For that reason maps summarizing the geological environment of Linn County are being prepared to aid in making landuse decisions and to help solve

problems arising from man's interactions with his physical environment. These maps will provide information on surface topography and materials, thickness and stratigraphy of consolidated sediments, bedrock type and topography, surface and groundwater resources, and flood-prone areas. Maps delineating the above data will delineate regions having high, moderate and low environmental hazard for various landuse practices.

6. Cooperative Research. To implement research in Iowa the Survey uses the authority granted in Chapter 305.8, Code of Iowa, to cooperate with Federal agencies in cost-sharing programs. During the 1971-73 biennium the Survey continued a 50/50 cost-sharing cooperative program with the Water Resources Division of the U.S. Geological Survey. The objectives of the program are threefold: (1) to inventory the groundwater resource, which involves an overall appraisal of groundwater occurrence and quality in an aquifer- or basin-wide organization of information; (2) to maintain surveillance of the groundwater resource which involves maintaining a network of observation wells to determine water-level and chemical-quality changes; and (3) to maintain a system for collection and compilation of basic records of daily stage and flow rate of streams, and the concentration and total load of sediments carried by streams. The data gathered in these programs form the foundation for good water-management policies and comprehensive planning.

In the absence of a Legislative mandate the Survey did not enter into a cooperative agreement with the Topographic Division of the U.S. Geological

Survey during the 1971-73 biennium. However, the amount of direct Federal money allocated for topographic mapping in Iowa was sharply increased and hence the rate of topographic map coverage has increased proportionately during the biennium.

VIII. IOWA REMOTE SENSING LABORATORY

Introduction

The legislature established a remote sensing laboratory within the Iowa Geological Survey in 1971. The laboratory was established to coordinate aerial data acquisition; to provide data analysis equipment and interpretive expertise; and to provide systems for the storage of remotely sensed data in formats which will make it more usable and understandable by state users. As originally developed, the laboratory was created to serve the information needs of 24 State and Federal agencies operating in Iowa (fig. 4).

Environmental Investigations:

1. Thermal investigations of the Mississippi River in Iowa. The Remote Sensing Laboratory, Commonwealth Edison, and the Iowa Conservation Commission conducted two thermal and multispectral airborne mapping missions over the Mississippi River in Iowa in June and September of 1971. A third data collection mission was flown on 14 February 1972 to make a visible and photographic record of open water areas during the coldest portions of the year. The purpose of these missions was to determine the existing thermal regimen of the river system prior to the operation of large power plants which will use river water for cooling purposes. Thermal data and information was furnished to Iowa agencies involved in the granting of permits to operate diffuser pipes in the river at Cordova, Illinois.

This project illustrated the feasibility of rapidly detecting point sources of thermal pollution. The results of this project have been published in two technical

REMOTE SENSING USER AGENCIES IN IOWA

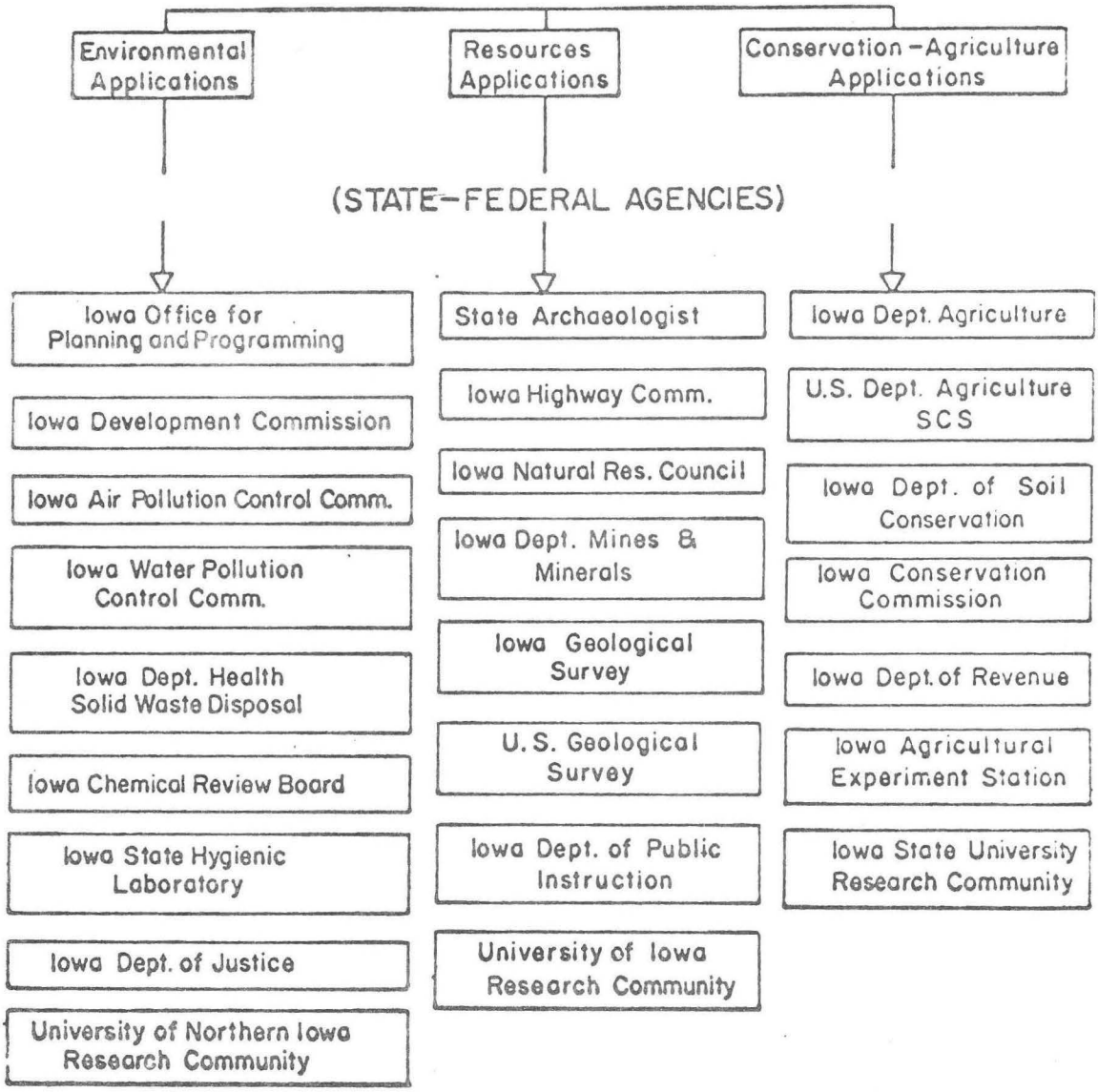


Figure 4.

papers, and a third comprehensive report is in preparation. There was no cost to the State of Iowa as Commonwealth Edison Company funded the thermal data acquisition.

2. Base Line Data for Studying the Effects of Cooling Tower Discharge on Vegetation. Iowa Electric Company and Iowa Remote Sensing Laboratory in cooperation with the U.S. Geological Survey acquired multispectral photography over the Palo Power Plant site near Cedar Rapids. The coverage extended north and south of the plant site to map vegetation prior to the operation of the condenser system. On the ground surveys included traverses through cropland and forestland. Additional data acquisition missions are planned for yearly periods following start-up of the Atomic Power Plant. The costs for data acquisition were shared by Iowa Electric Company and the U.S. Geological Survey.

3. Thermal Monitoring of Power Plant Discharges. The U.S. Environmental Protection Agency, Iowa Department of Environmental Quality, and Remote Sensing Laboratory have been cooperating in a series of overflights to detect and map thermal outfalls associated with power generating plants in Iowa. Plants in Des Moines, Waterloo, Cedar Rapids, and along the Missouri River are being repeatedly over-flown using the EPA aircraft and thermal mapping system. EPA staff have been analyzing the imagery through the use of the Remote Sensing Laboratory equipment.

4. Feedlot and Sewage Lagoon Inventory. The Iowa Department of Environmental Quality, using the staff expertise of the Remote Sensing Laboratory, has requested that the U.S. Environmental Protection Agency provide imagery over an area covering

15 counties in south-central Iowa. Iowa Remote Sensing Laboratory has agreed to provide film and film processing, and to provide the necessary staff for interpretation of the imagery. This inventory would determine existing feedlots and sewage lagoons for the purpose of granting of permits to operate.

Natural Resource Investigations:

1. Flood Inundation Mapping. Evaluation of multispectral imagery from three floods occurring at different times of year in Iowa has indicated methods of mapping flood inundation several days after flood water has returned to the main river channel. Cooperative study by the Iowa Geological Survey, Remote Sensing Laboratory (IGSRSL), and the U.S. Geological Survey, Water Resources Division, on flooding in three seasons suggests that color infrared film would provide flood inundation data having the highest multiplicity of possible uses for flood plain management-planning in Iowa. ERTS-1 satellite data reinforced the basic conclusions of the low-altitude studies. The satellite imagery also allowed the rapid appraisal of the areal extent of flood inundation on a regional scale.

Five publications report the significant results of this study and a comprehensive report is in final preparation. The project was funded by the U.S. Geological Survey, and approximately $2,100 was expended in support of the project. The project research was reported at a national meeting at Goddard Space Flight Center, Maryland, and the IGSRSL paper was selected from over 170 papers to be one of four presented before the conference at large. The National Aeronautics and Space Administration has published in color the significant results of this project.

2. Floodplain Analysis. Another important aspect of the flood investigations being conducted by Remote Sensing Laboratory staff deals with the correlation of floods with particular soil series located on the floodplain. The Earth Resources Satellite (ERTS-1) imagery acquired in October 1972 alerted IGSRSL interpreters that the 100-year flood boundary coincided very closely with particular soils. On the October satellite imagery the Nishnabotna River floodplains, which were inundated by a "100-year flood", appeared similar to floodplains on the Boyer and other rivers. The Remote Sensing Laboratory staff then examined soil maps of the flooded area and found close coincidence between soil series and the boundary of the Nishnabotna flood crest. If soil mapping is able to quantify the magnitude, frequency, and distribution of flooding along rivers in Iowa, then prediction of flood inundated areas may be possible. Ultimately, it may be possible to develop an operational definition of what constitutes the floodplain for landuse planning purposes. Remote Sensing Laboratory staff are cooperating with the members of the soils faculty, Department of Agronomy, Iowa State University, in this study. The initial analysis will be included in the Nishnabotna flood report (Public Information Circular 6), which is in final preparation.

3. Study of Ponded Waters. The Iowa Natural Resources Council and Remote Sensing Laboratory staff have been examining imagery of the Iowa landscape to make an inventory of ponds and artificial lakes. Preliminary studies using high-altitude color infrared imagery over Ottumwa, Iowa, indicate that many small ponds and artificial lakes in this area have not been recorded by the Natural

Resources Council. Personnel in the Natural Resources Council are now training interpreters to evaluate color infrared imagery and spacecraft imagery over larger areas in Iowa.

4. Cedar River Hydrologic Study. The U.S. Geological Survey has been studying the hydrology of the Cedar River basin for the past several years. The USGS and Remote Sensing Laboratory are currently using remote sensing data, multispectral imagery and thermal radiometer data, to examine the hydrologic characteristics of the basin. Karst features, collapse structures, and large fracture systems are being analyzed utilizing hand-held 35mm photography, thermal infrared radiometers, and existing multispectral photography. Ultimately, this data could provide information for environmental geologic analysis necessary for land capability planning.

Land and Water Planning Investigations:

1. Eleven-County Landuse Analysis for South-Central Iowa. The Remote Sensing Laboratory is analyzing an eleven county area in South-Central Iowa under a $31,000.00 grant from the EROS Program, U.S. Geological Survey, Department of the Interior, Washington, D.C. This project is applying ERTS-1 satellite data to the information needs of state and local planners involved in land- and water-use management in this central region of Iowa. The project utilizes direct input from the local planners in the area and in the spring of 1973 the Chariton Valley Resource Conservation and Development Project and Iowa State University Extension Service arranged meetings with county and city

officials, representatives of the Rathbun Planning Commission and the Rathbun Water Association for IGSRSL personnel. The input from planners has enabled IGSRSL staff to modify landuse, water resources, and mineral resources maps, derived from ERTS-1 and other imagery sources, to more closely fit the information needs of these planning groups.

Initial contact with these planning agencies in February of 1973 resulted in the development of an imagery acquisition subcommittee composed of planners from the eleven counties. Portions of Rathbun Lake, Red Rock Lake and the Des Moines River have been overflown using the multispectral camera to assess siltation, soil erosion, and brush development. The Iowa Conservation Commission is using this imagery to identify wetlands, brush development in wetlands, water fowl, and for identification of diseased conifers in the area. Imagery is also being examined for archaeological sites.

A final report on the eleven-county study area will be prepared in November 1973 and this report will be a comprehensive, illustrated report including thematic maps produced directly from spacecraft- and aircraft-acquired data, and illustrating the applications defined and their relative impact relative to costs and benefits on the State and county agencies that have participated. The published results of the study will include 14 thematic maps at the scale of 1:250,000, an evaluation of the methods used, and a glossary of technical terms for non-scientist planners. This project is viewed by officials in Federal and State government as the first steps toward a comprehensive landuse inventory and land capability for the State of Iowa.

2. Environmental Geology of Surficial Materials in Iowa. In June of 1972, Iowa Geological Survey, Remote Sensing Laboratory received a grant from the U.S. Geological Survey, Denver, Colorado, amounting to $40,000.00 to evaluate the capabilities of remote sensor data from the Earth Resources Technology Satellite (ERTS-1) for mapping surficial deposits and landforms in the Midwest and Great Plains. Under the grant the co-principal investigator is a member of the IGSRSL staff and the Remote Sensing Laboratory is the center of investigations for the program, coordinating the efforts of five other collaborating state geological surveys surrounding the State of Iowa. The initial evaluation of the capabilities of using satellite imagery for landuse inventory was made under this program. The flood inundation mapping studies were also undertaken using imagery provided through this grant. The State of Iowa now has a complete set of spacecraft imagery covering Iowa and surrounding states. The program will provide a synoptic view of landuse and landforms, particularly as they relate to management-planning in other states surrounding Iowa. Ultimately, an understanding of regional relationships regarding soils, unconsolidated materials and their relationships to bedrock will enable Iowa planners and agency personnel to more effectively manage the Iowa landscape.

3. Detection of Historic and Archaeological Sites. The Remote Sensing Laboratory has a continuing program with the Office of the State Archaeologist, The University of Iowa Anthropology Department, and the Iowa Conservation Commission to develop a method of detecting archaeological and historic sites prior to the civil works of man. This program includes the acquisition of repetitive multispectral

photography over known archaeological and historic sites, and examination of imagery over areas where sites are likely to be present. Current research is being conducted at The University of Iowa to develop a method for utilizing the synoptic and multispectral character of remotely sensed data for detection of such sites in the Midwest.

4. Conservation Inventory. The Remote Sensing Laboratory staff have been cooperating with staff from the Iowa Conservation Commission in developing analytical techniques applicable to the functions of their agency. For example, because ungrazed timber areas are potentially better grouse habitat areas, techniques for delineating grazed versus ungrazed timber areas are being evaluated. Another study being done with Conservation Commission personnel is directed at developing a method for inventorying waterfowl in a quantitative manner. This program utilizes color infrared and black and white infrared photography to inventory blue and snow geese. The Iowa Conservation Commission is also investigating the use of color infrared photography for inventory of wetlands. Discussions are underway with Conservation Commission personnel to develop techniques for monitoring recreational use of the Mississippi and Missouri River systems. This project is designed to determine periods and areas of maximum use so conservation officers can staff to meet peak demand periods and areas.

Educational Programs:

1. Seminar in Applied Remote Sensing. In May of 1972 the Remote Sensing Laboratory organized a Seminar in Applied Remote Sensing in Des Moines to train

personnel from the twenty-four user agencies in remote sensing techniques. The seminar was attended by over 40 persons and included attendees from the U.S. Department of Agriculture, Washington, D.C.; U.S. Army Corps of Engineers, Kansas City and St. Louis; and U.S. Geological Survey, Washington, D.C. Because of the success of this course, many agencies requested Remote Sensing Laboratory staff give abbreviated courses and lectures in their own agency headquarters. Numerous agencies have requested an additional course in Iowa City, perhaps lasting only one or two days.

2. Remote Sensing Newsletter. The Remote Sensing Laboratory publishes a newsletter approximately four times a year. The mailing list includes interested Iowa Legislators, State and Federal agency personnel, and scientists in the remote sensing research community at large. The purpose of this publication is to inform agency personnel and legislators of ongoing remote sensing investigations that may pertain to their interests, to share research experiences with others in the remote sensing field, and to announce the availability of imagery and publications. The current circulation of the newsletter is 550 persons or agencies.

3. Inquiries on Remote Sensing Laboratory Activities. In the past biennium the Remote Sensing Laboratory has received 53 letters from Federal agencies requesting information about the development of the remote sensing program and requesting publications. Twenty-six states have requested to receive additional information concerning the organization of the Iowa program. Eleven states are now developing remote sensing programs similar to Iowa's and four states have sent

personnel to Iowa to visit the laboratory for first-hand information. The Food and Agriculture Organization of the United Nations, Rome, Italy, has corresponded with the laboratory to arrange the sending of a United Nations staff member to Iowa to learn satellite remote sensing techniques and to observe the operation of the Iowa remote sensing program.

4. Public Information Program. During the past biennium, Remote Sensing Laboratory staff have presented over 46 lectures to the public describing the Iowa remote sensing program.

5. Introduction of Remote Sensing in Institutions of Higher Education. In response to the need for individuals trained from an interdisciplinary background in photointerpretation, remote sensing, and photogrammetry, the Remote Sensing Laboratory developed a coordinated program of university research and teaching between Iowa's three major universities. A total of six courses are now offered in remote sensing at the university level where none were offered prior to 1972. Now students and faculty are exchanged between institutions, and those engaged in research can utilize facilities and equipment at either university or in the Remote Sensing Laboratory. The Remote Sensing Laboratory provides the impetus for the interdisciplinary program because it repeatedly brings together basic researchers in the academic community, analysts of imagery, and those applying the analyses to practical problems of natural resource management, land utilization planning, and environmental control in Iowa.

IX. EXTENDED OFFICE HOURS

On 1 January 1973 the Survey began an experiment in extending the number of hours per week that the agency office would be open to the public. With the office open from 7:30 a.m. to 6:30 p.m., Monday through Saturday, an additional 20 hours of availability were achieved. Personnel were selectively assigned to Staff A or Staff B in order to assure expertise in all the Survey functions at all times.

Staff A started the schedule working 10 hours per day Monday through Thursday, with Staff B working Wednesday through Saturday. At the end of each four-week period the schedule is rotated. Under this plan each person completes the 40-hour work week in four days, which allows extra free time for the employee while at the same time extending the office hours of the agency.

At the start of the new schedule the reaction to the plan was mixed. Previously it was not unusual for various staff members to work several hours on Saturdays on special projects. However the idea of being committed to four 10-hour Saturdays in a row was not especially attractive. After six months on the new schedule much of that concern has dissipated.

In concept, each staff member should have three free days per week. However, because of the extensive staff interface with other agencies that remain on a standard 5-day schedule and because of requests for appointments on scheduled free days, it is seldom that the professional staff actually achieves full advantage of the free days.

A rather unexpected advantage of the new schedule has been a partial relief of the crowded working conditions in the Survey offices. Also, because most of the Federal and State agencies and industries that utilize the Survey services end their office hours at 4:30 or 5:00 p.m., the number of telephone calls after 5:00 p.m. and on Saturdays is markedly less than during the rest of the work period. The staff generally agrees that because of the fewer interruptions this is a time of greater productivity.

In summary, the general attitude of the staff to the new schedule is one of approval. Although the average number of hours worked per week has increased, the knowledge that the extra free time is available if appointment schedules permit appears to be adequate compensation.