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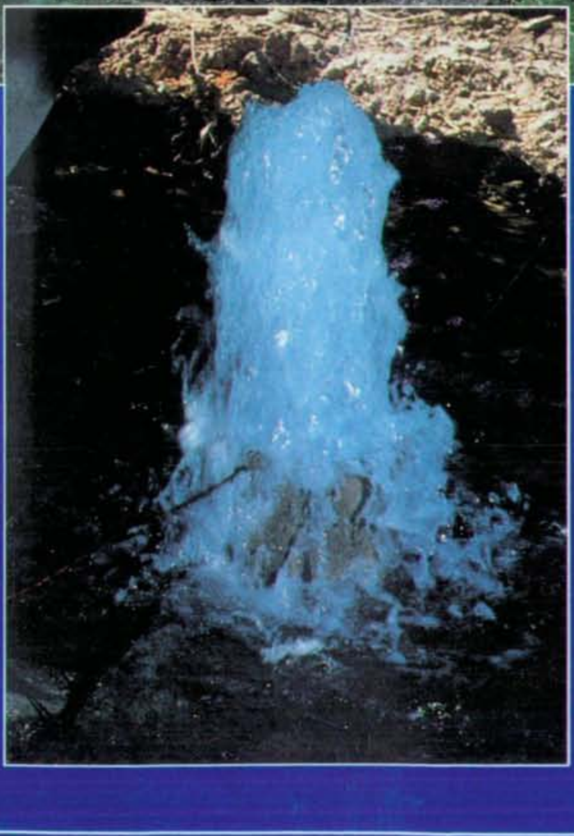
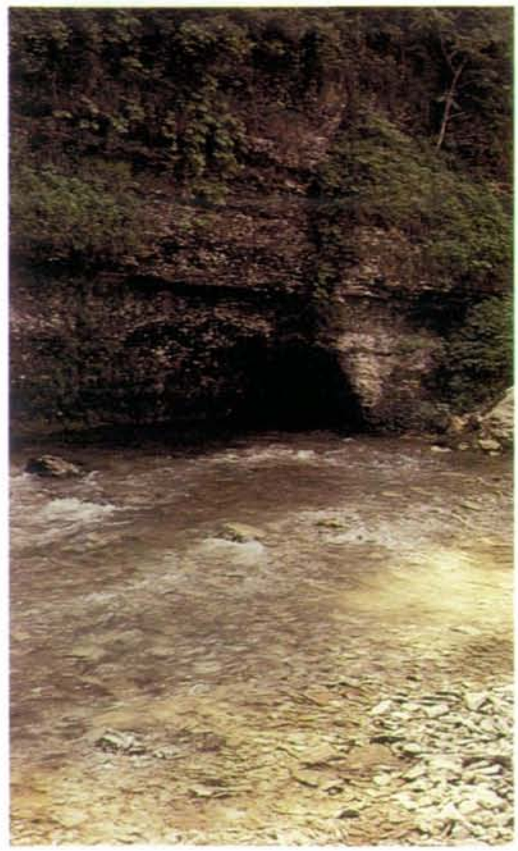


Using Ground-Water Data For Water Planning

sponsored by the Legislative Commission on Minnesota Resources



Do we need ground water?

Our lives depend on it. In rural Minnesota almost all of our water used is ground water, and 93 percent of all municipal systems use it. St. Paul now uses some ground water, and Minneapolis is considering its use to supplement water from the Mississippi River. Minnesota's dependence on ground water is increasing: in 1976 only 14 percent of all the water used was ground water; by 1985 ground water was 25 percent of all the water used.

Front cover: Flowing artesian wells—the water is forced upward by water pressure in the aquifers.

Using Ground-Water Data For Water Planning

By
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with the cooperation of the
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Minnesota Department of Natural Resources, Division of Waters
Minnesota Pollution Control Agency
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What is Ground Water?

Ground water is water stored beneath the earth's surface in cracks, crevices, and pore spaces in the geologic materials that make up the earth's crust.

Where does ground water come from?
Ground water originates as precipitation, but not all rain or snowmelt becomes ground water. Some of it evaporates back into the atmosphere. Much of it becomes runoff, replenishing rivers, lakes, and oceans. The rest soaks into the ground, trickling down through the soil.

As water moves down through the soil, some is retained near the surface in the unsaturated zone, where the spaces in soil and rock are filled with either water or air. Some of the water in the unsaturated zone is taken up by plants and returned to the atmosphere by transpiration.

As water in the unsaturated zone continues percolating downward, it passes into the saturated zone, where all the pore spaces are filled with water. The *water table* is the boundary between the unsaturated zone and the saturated zone. The water stored in the saturated zone is called ground water.

Under what conditions does ground water provide a usable supply of water?
Two properties of geologic materials determine their ability to supply water—*porosity* (amount of space to store water) and their *permeability* (how well connected the spaces are). The greater the porosity and permeability, the more ground water geologic materials will yield.

An underground, saturated, permeable geologic formation capable of producing significant quantities of water to a well or spring is called an *aquifer.* Aquifers vary tremendously in size. They may be anywhere from a few feet to hundreds of feet thick. They may be found just beneath the surface or hundreds of feet beneath the surface. They may underlie a few acres or thousands of square miles.

Once used, how is a ground-water supply replenished?
Recharge is the process by which water percolates from the earth's surface down through the soil to become ground water. Recharge typically occurs in upland areas, with the ground water then moving to lowland areas where it is discharged into wetlands, streams, lakes, or springs. This movement of ground water is usually very slow, at a rate varying from a few inches per day to a few feet per year. Once the ground water is discharged above ground, it can evaporate back into the atmosphere, and the cycle begins again.

Can a ground water supply be overused?
Yes. *Drawdown* of an aquifer is a decline in the water level due to ground-water withdrawals. *Overdraft* (or ground-water mining) is a continued decline in water level due to long-term withdrawal in excess of recharge.

When the amount of water withdrawn from an aquifer is replenished or recharged with an equal amount of water, balanced use is occurring, and the average water level of the aquifer remains relatively constant.

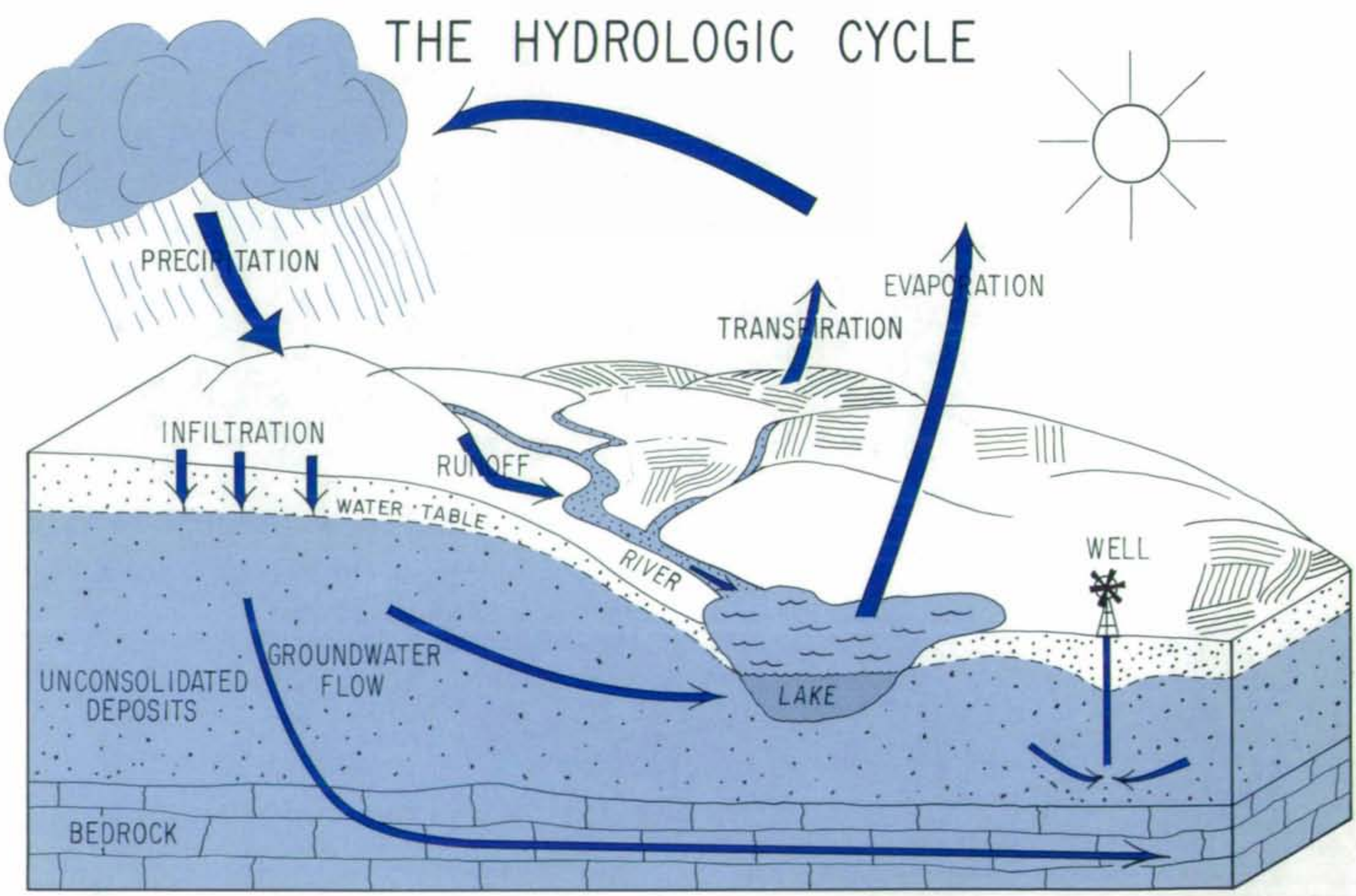


Diagram by Eric Mohring.

Introduction

Thoughtful and broad-based planning is the foundation for wise use and management of Minnesota's ground-water resources. Effective water planning must match a variety of resource questions with appropriate types of data. The ability to understand ground water is limited because ground water is an "unseen" resource. We must rely on information from single points, such as individual monitoring wells, to piece together the resource picture. Hundreds of thousands of single point observations about Minnesota's ground water have been generated by government and the private sector. These data must be arranged and maintained in storage and retrieval libraries if they are to be used efficiently to answer ground-water questions.

Data, however, are merely the tools for decision-making; this cannot be overemphasized. Data arrangement showing ground-water conditions will affect how a water management question is perceived, as well as how accurately or completely it can be answered. Appropriately designed data bases are the best means to ensure that all available ground-water information is used to portray conditions realistically. This booklet is an introduction to the use of existing data systems and the integration and development of data management systems into water planning.

Using Ground-Water Data: Getting Started

As our society has become complex, so have ground-water problems. Questions about ground-water resources provide the basis for defining problems and issues to be addressed by local water planning. Some have already been considered by state agencies and by the legislature in general terms, and state decisions concerning ground water are an important consideration in local planning. However, local issues require local water plans that will enhance everyone's awareness of ground-water problems.

Some questions have been asked since pioneer days, while others have been raised within the past decade. However, whether questions about our ground-water resources are old or new, they generally fall into two major categories.

Some ground-water questions can be answered easily with available information. Usually, this type of question can be answered readily either locally or at the state agency level. They fall into several categories:

- general information questions about the nature of ground water or related terminology
- questions relating to the quantity or quality of ground water on a specific property
- questions concerning regulations governing the use or protection of ground-water supplies.

Some ground-water questions require compilation of existing data and possibly additional research to answer. This type of question usually requires prior technical analysis of data. Such questions include:

- the distribution and quantity of ground-water resources throughout an area
- the effects of land use on the quantity and/or quality of ground-water resources

- the interaction between surface and ground water and its significance to water planning
- the public health effects of drinking contaminated ground water
- regulating or prosecuting those responsible for misuse or degradation of ground-water resources.

Examples of this category of question, which are listed below, have no general answers that would prove satisfactory or technically accurate throughout the state. Instead, procedures for answering this type of question are presented in the following sections of this booklet and may be useful for water planning.

Where are the aquifers in our county?
Which direction does ground water move and how fast?
How much ground water is available and are we already using too much?

Q: ***How deep do I have to drill for water on my property?***

A: The depth of a new well depends on several factors—

(1) **local geologic and hydrologic conditions,** which determine the depth below the land surface of an aquifer, as well as its ability to store and transmit water.

(2) **the amount of water required from the well,** which must be matched to the yield capabilities of local aquifer systems, taking into account the pumping effects of surrounding wells.

(3) **state regulations which govern well construction and the appropriation of ground water.** All well construction must comply with state regulations administered by the Minnesota Department of Health. No minimum depth is required, but new wells may not be completed in some aquifers if certain geologic conditions exist or if the ground water is contaminated.

Data sources: Water-well records provide information about local well depths, aquifer yield potentials, and geologic conditions. Also, ground-water studies and reports, when available, are useful for identifying aquifers suitable for particular water uses, such as domestic or irrigation purposes.

The Minnesota Department of Health and the Division of Waters of the Minnesota Department of Natural Resources will answer questions about the regulatory aspects of well construction and pumping. Summaries of water well records are maintained in the Well Log Listing System (WELLS) developed by the Minnesota Geological Survey and the Department of Natural Resources. To obtain all the information on a record, contact the Minnesota Geological Survey which serves as the state repository of well records obtained from public and private sources.

Q: ***Should I have my well tested for contamination and who will do this for me?***

A: It is generally a good idea to have the water quality checked periodically if a well is supposed to supply potable water. Before a new well is put into service, the well water must be analyzed to determine its potability. The most cost-effective tests are for the presence of nitrate nitrogen and coliform bacteria. Nitrate nitrogen concentration in ground water under natural conditions is not thought to exceed one part per million (1 milligram per liter). The presence of nitrate nitrogen above this level indicates that the well is being contaminated from sources such as septic tanks or agricultural fertilization. Coliform bacteria live in the intestinal tracts of humans and animals, and their presence in a well indicates that the well is being contaminated by septic tanks or barnyard wastes.

Nitrate nitrogen and coliform bacteria testing of well water is offered by some county and community health services programs and by laboratories accredited by the Minnesota Department of Health. Costs are variable but are generally under $50. The tests are good, but not totally conclusive indicators of contamination. Analyzing well water for other contaminants, such as industrial solvents, petroleum products, and pesticides, is more expensive and could cost hundreds or even thousands of dollars depending on the number and types of contaminants thought to be present. Historic data may provide an indication of which, if any, compounds may be entering the ground water in specific areas.

Data sources: Analyses of nitrate nitrogen and coliform bacteria from well water are collected by local health departments or other community health services programs. The Minnesota Department of Health receives copies of these analyses for all new water wells, and the Minnesota Department of Agriculture tests wells for coliform bacteria and nitrate nitrogen for their grade-A dairy program.

Analyses for contaminants other than nitrate nitrogen and coliform bacteria are on file at a variety of state and federal agencies. The lead agencies to contact are the Minnesota Department of Health and the Minnesota Pollution Control Agency. Both agencies cooperate with many others to test ground-water quality and can assist in identifying local sources for these data.

Q: ***Whom do I contact for information about the availability of ground water in my area?***

A: State and federal agencies are involved in some facet of water-resource investigations, as are college and state universities. Much of this activity is coordinated through agency or legislative programs, while some involves input by individuals or groups. No single agency or research department serves as a repository for all of the information collected, but several programs will contain or have access to much of it.

What are the impacts on ground water from local land uses, such as agriculture, housing developments, landfills, industrial parks, and community well fields?

Do improperly constructed or abandoned water wells pose a threat to ground-water resources?

How far below the land surface is the water table and does ground water influence lake and stream levels?

These questions require multi-disciplinary approaches to answer and emphasize the need to incorporate accurate information about our ground-water resources with carefully considered planning and management procedures. Otherwise, an effective strategy to conserve and protect Minnesota's ground-water resources will not be possible.

Data sources: Although no entity is responsible for the overall direction of ground-water research, the Division of Waters of the Minnesota Department of Natural Resources directs management and protection of ground-water quantity. It has supported much of the work designed to identify the distribution and yield potential of the state's aquifers. Research and field work has come from the Water Resources Division of the U.S. Geological Survey. The starting point for these studies, understanding basic geologic conditions, is coordinated by the Minnesota Geological Survey. All three organizations have compiled libraries of studies and data relating to geologic conditions and the occurrences of ground water. Generalized information is available across much of the state. Detailed studies cover only very specific areas.

Q: ***Who regulates water-well construction and does any agency have the authority to condemn my well?***

A: The Minnesota Department of Health is responsible for enforcing state law governing well construction and the licensing of water-well contractors (Minnesota Statutes, Chapter 156A). Well drillers must be licensed by the Department of Health and yearly renewal is required. Materials used to construct a well and the installation method must be approved. Altering the construction of an existing well requires that it be brought to code. Special well construction and grouting are required for wells located in karst or carbonate limestone areas subject to ground-water contamination. Inspection and investigations of well contamination or water supplies are conducted within the staffing limitations of the Department.

County community health services agencies may enter into an agreement with the Department of Health to establish county well programs. Local control must be at least as strict as state regulations, but may include additional construction and inspection requirements if factors such as geologic conditions necessitate.

Minnesota Statutes, Chapter 156A, requires that a water well must be sealed if it is abandoned or not servicing its intended use. Well abandonment must be performed by a licensed water-well contractor according to Minnesota Department of Health regulations.

Data sources: Contact the Minnesota Department of Health for information about well construction and abandonment or about the licensing of water-well contractors. The Minnesota Geological Survey can provide information about geologic conditions when state regulations require specific methods of well construction or abandonment.

Q: ***Can any agency determine if a neighboring well will take water away from my well?***

A: The Division of Waters of the Minnesota Department of Natural Resources is responsible for enforcing state law governing ground-water appropriations (Minnesota Statutes, Chapter 105). All wells which pump more than one million gallons of water per year, ten thousand gallons per day, or which are used by more than 25 people are required to have a ground-water appropriation permit. Permits set pumpage limits based on the request for water use and on ground-water availability. Yearly pumpage reports are required of the permittee and this information is entered into the State Water Use Data System (SWUDS).

The Minnesota Department of Natural Resources in cooperation with the Water Resources Division of the U.S. Geological Survey and Soil and Water Conservation Districts maintains a network of observation wells to monitor ground-water levels, particularly in areas of heavy pumpage. Although this network of wells is not uniformly distributed and needs to be expanded, it provides information necessary to determine if pumpage will exceed recharge rates for many areas. In addition, aquifer studies help to define ground-water availability.

Many well-interference problems investigated by the Minnesota Department of Natural Resources are caused by construction methods rather than by aquifer depletion due to high-capacity pumping. For example, pumpage from a well that penetrates only the top part of an aquifer will cause a water-level decline over a wider area than the same pumpage rate from a well that penetrates the entire thickness of the aquifer.

Data sources: The Division of Waters of the Minnesota Department of Natural Resources should be contacted for questions concerning local ground-water appropriations and the impacts of existing pumpage on ground-water supply. The Water Resources Division of the U.S. Geological Survey can provide information about aquifer yield potential in areas that have been studied in detail. Both agencies collect statistics about ground-water use and contribute this information to the SWUDS data base.

Understanding Map Scale

Planners and decision makers often prefer to have ground-water information presented in an interpreted form related to a specific question, rather than to have a pile of raw data which may be almost meaningless. Maps are an excellent way to portray interpreted data, but care must be exercised in preparing and using them. The major consideration in using maps is selecting and using a map scale which accurately represents the limits of available data while still providing meaningful information.

Large-scale mapping of local ground-water conditions will probably not be available on a county-wide basis but may be achieved over time as more comprehensive data bases are developed locally and in cooperation with state and federal agencies. Local water planning processes can identify areas where further study of ground-water conditions is warranted to meet local needs.

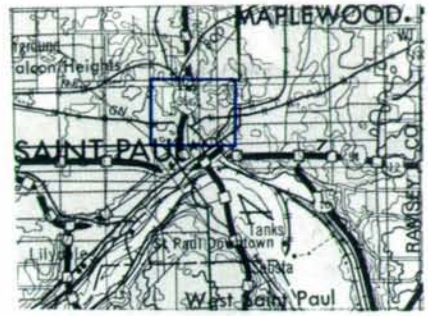
It is important to recognize that maps represent interplay between data and interpretation. Abundant good data, ineptly interpreted, will result in a bad map.

Measuring a water level in a monitor well.

Test drilling to determine geologic conditions.

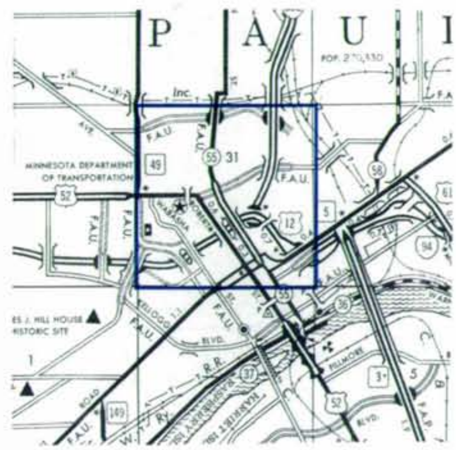
SCALE, DETAIL, AND ACCURACY OF MAPS

The maps on this page depict the same area around the state capitol in St. Paul at different scales. The small-scale map above is a suitable base map for regional ground-water studies. One inch on this map equals 250,000 inches or nearly 4 miles on the ground. Printed maps showing the entire state of Minnesota require still smaller scales of 1:500,000 (for a sheet of paper measuring 4 feet x 4.5 feet) or 1:1,000,000—the scale of the state highway maps.



U.S. Geological Survey, scale 1:250,000
(1 inch = nearly 4 miles)

In the center is an example of an intermediate-scale map. One inch on this map equals 63,360 inches (or about 1 mile) on the ground. The Minnesota Geological Survey uses maps at the slightly smaller scale of 1:100,000 for county geological atlases, which need to show county-wide information. The intermediate-scale map shown here could be enlarged photographically so that 1 inch equaled 2000 feet, as in the map below, but the amount of detail on the enlargement would be no greater than before. Furthermore each line on the enlargement would be 2.5 times thicker and therefore take up 2.5 times as much space! Enlarging a map may make it easier to work with, but does not improve either its accuracy or its precision.

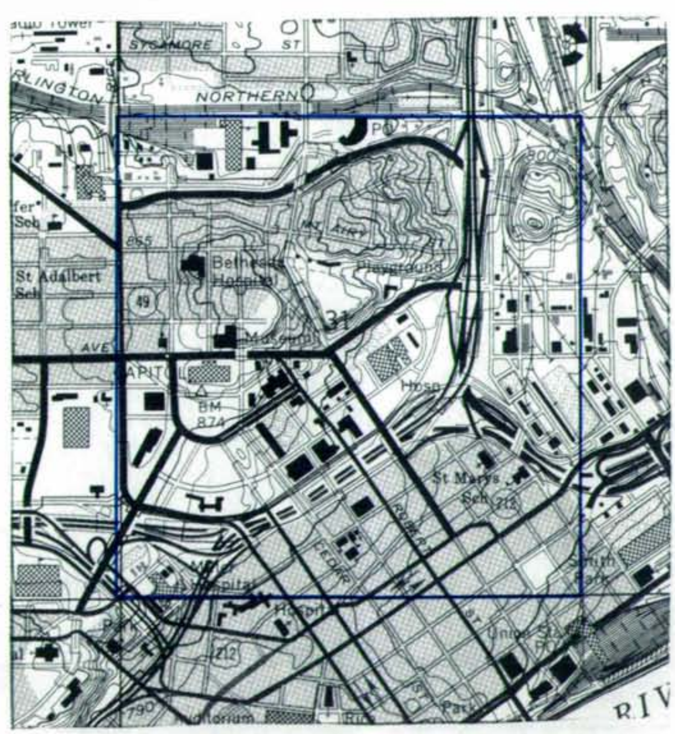


Minnesota Department of Transportation county highway map, scale 1:63,360
(1 inch = nearly 1 mile)

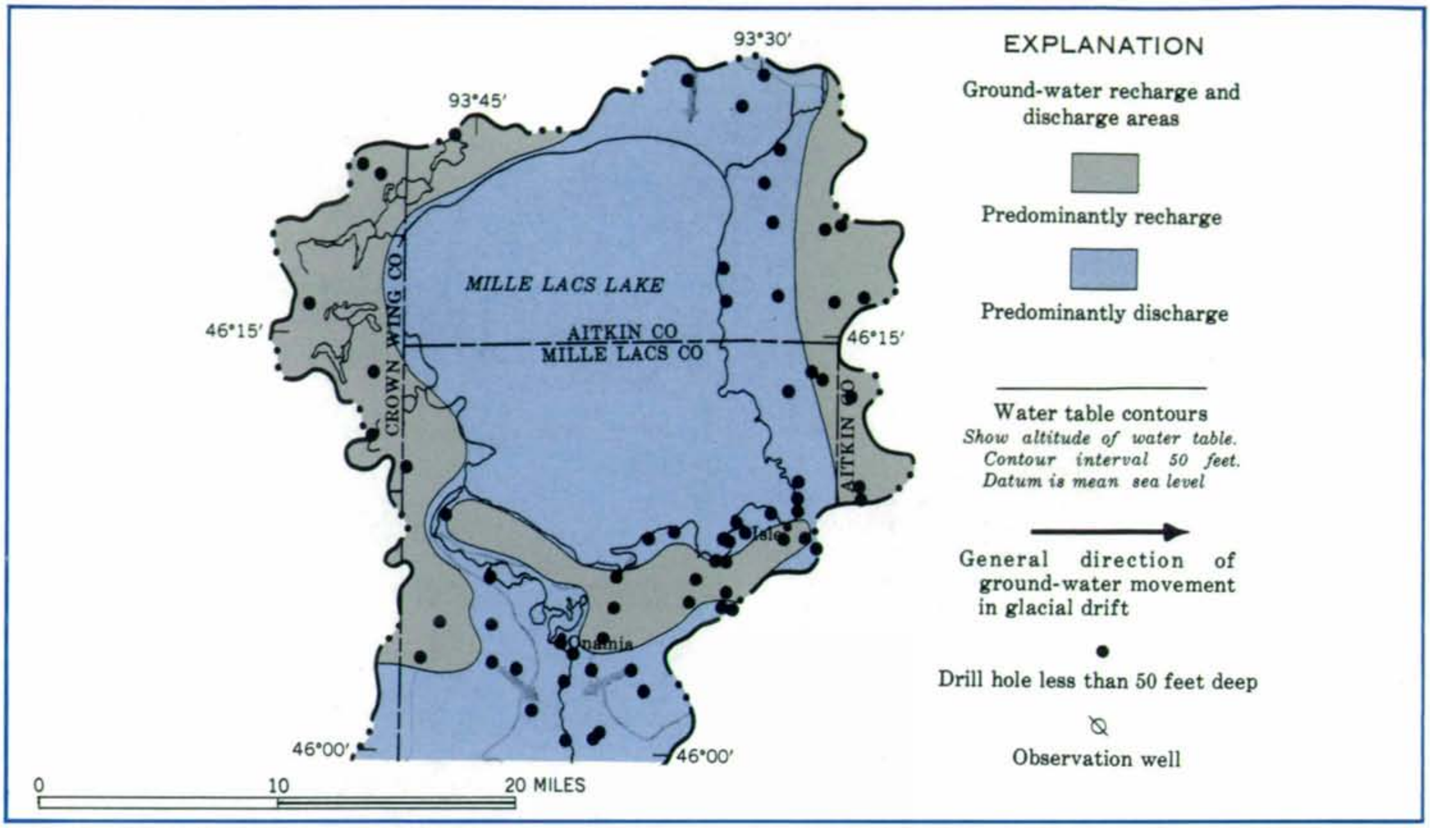
Maps at 1:24,000 scale (bottom) are useful for cataloging such locations as wells and springs, waste-disposal sites or other sources of possible contamination, sites of high-capacity ground-water withdrawal, and water-quality samples. Maps at this scale are also useful for topical studies, such as ground-water analyses around landfills and ground-water investigations around municipalities.

National accuracy standards require that features be plotted on the map within one fiftieth of an inch of their true position. On paper this represents different distances on the ground, depending on scale—about 400 feet at 1:250,000; about 100 feet at 1:63,360; and 40 feet at 1:24,000. Viewed this way, it is natural to conclude that the 1:24,000 map is the most accurate, and the 1:250,000 map the least. However, maps are only miniature representations of reality, and accuracy is probably better considered as a measure of the care of the entire map making process— including obtaining, measuring, recording, and printing the information displayed. Mislabeled buildings or erroneous contours on the large-scale map would make it less correct than the maps above it at smaller scales, if these features are correct on the smaller scale maps.

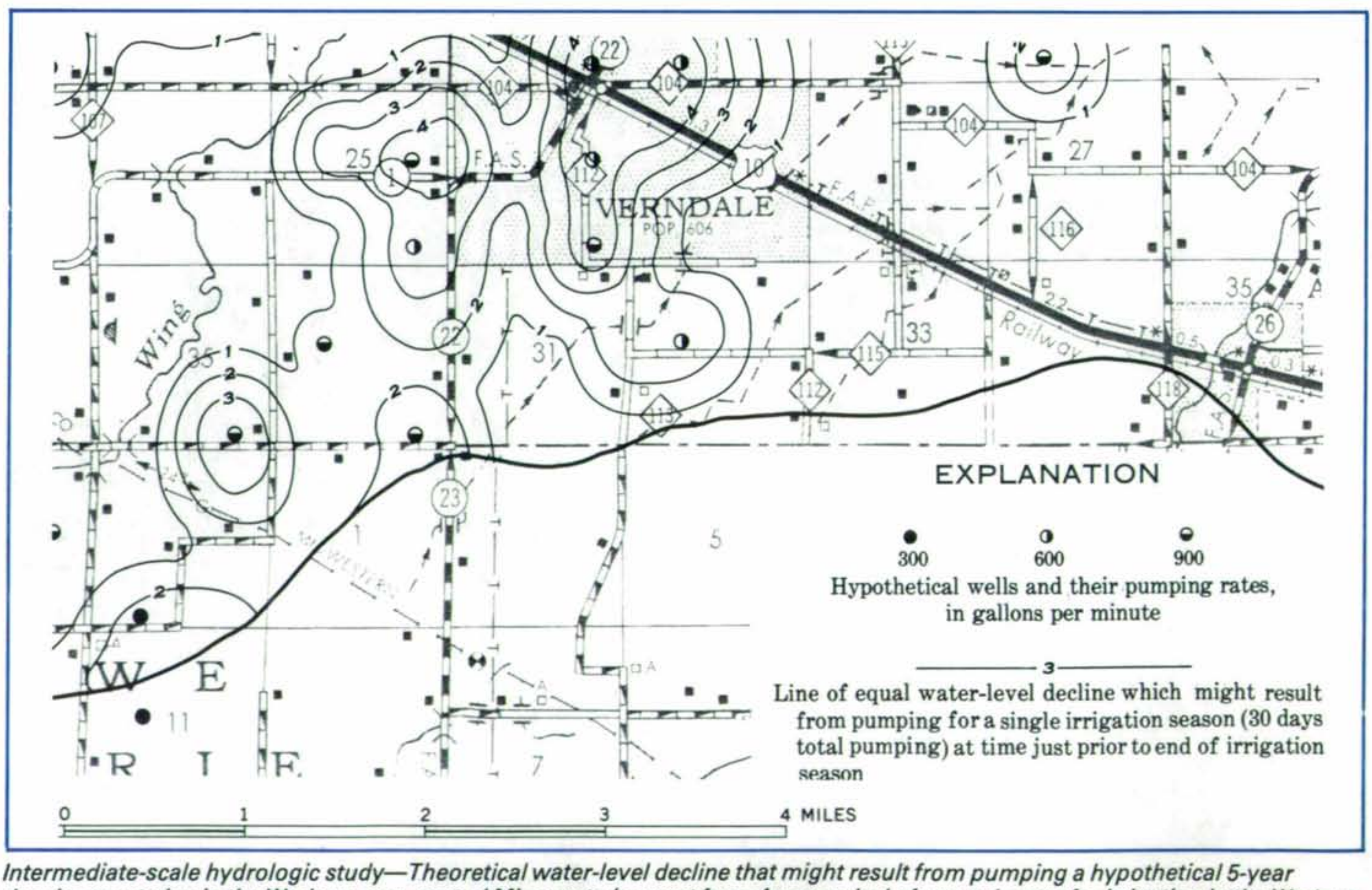
Comparison of the amount of detail and relative precision of the maps on this page helps to explain why 1:24,000 maps, even if enlarged, will not do for everything. For site-specific project planning, being correct within 40 feet horizontally and 5 or 10 feet vertically is just not close enough. Furthermore, maps at this scale cannot always portray enough detail.



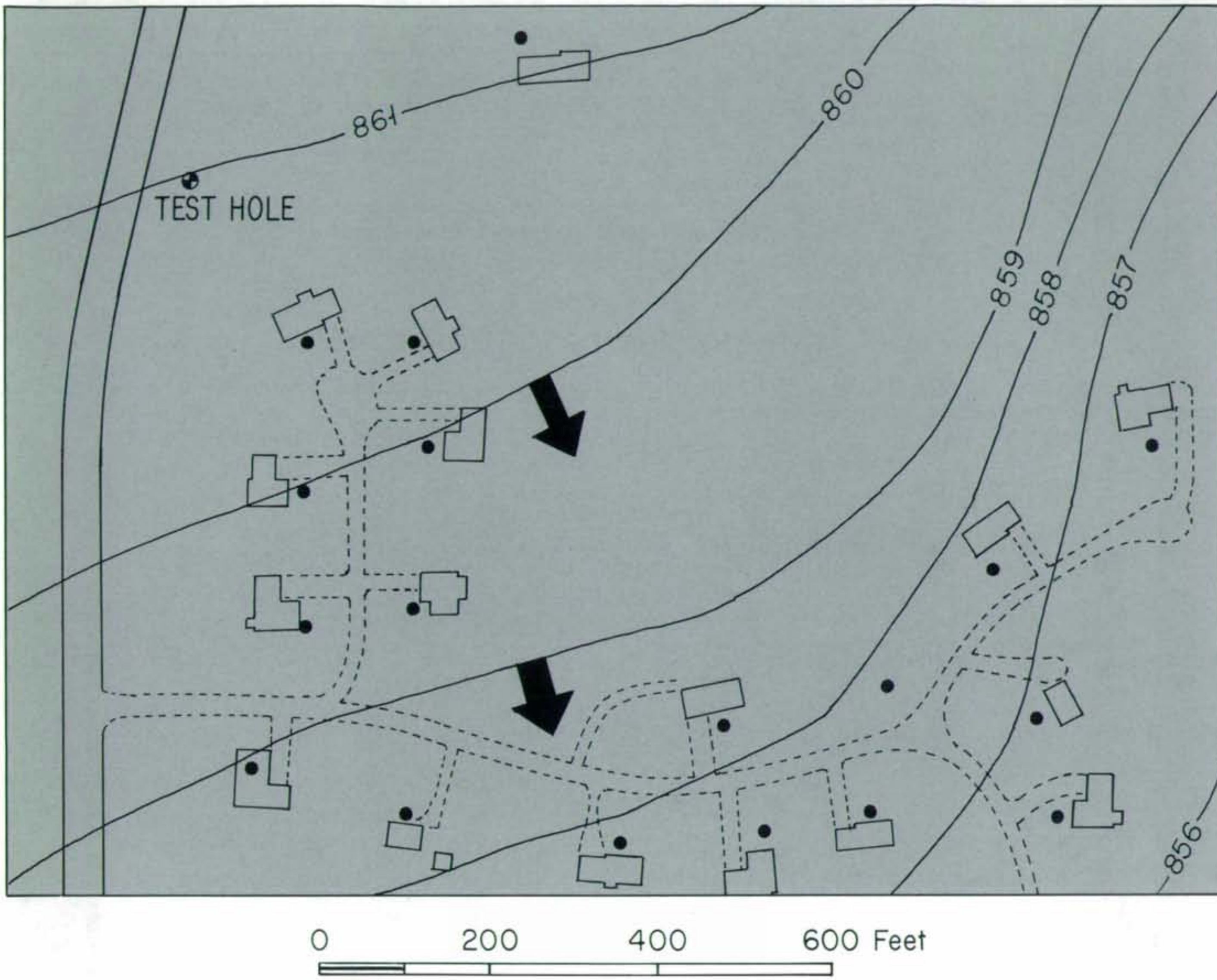
U.S. Geological Survey, St. Paul East quadrangle, scale 1:24,000
(1 inch = 2000 feet)



Example of a small-scale hydrologic study (excerpt from Water resources of the Rum River watershed, east central Minnesota; U.S. Geological Survey Hydrologic Investigations Atlas HA-509).



Intermediate-scale hydrologic study—Theoretical water-level decline that might result from pumping a hypothetical 5-year development plan in the Wadena area, central Minnesota (excerpt from An appraisal of ground water for irrigation in the Wadena area, central Minnesota; U.S. Geological Survey Water-Supply Paper 1983).



Large-scale hydrologic study—Map showing the potentiometric surface of the water table for a neighborhood in Anoka County (adapted from a land-fill study prepared by a private consultant). Solid dots are water wells, contours are lines of equal potential, and arrows show interpreted directions of ground-water flow.

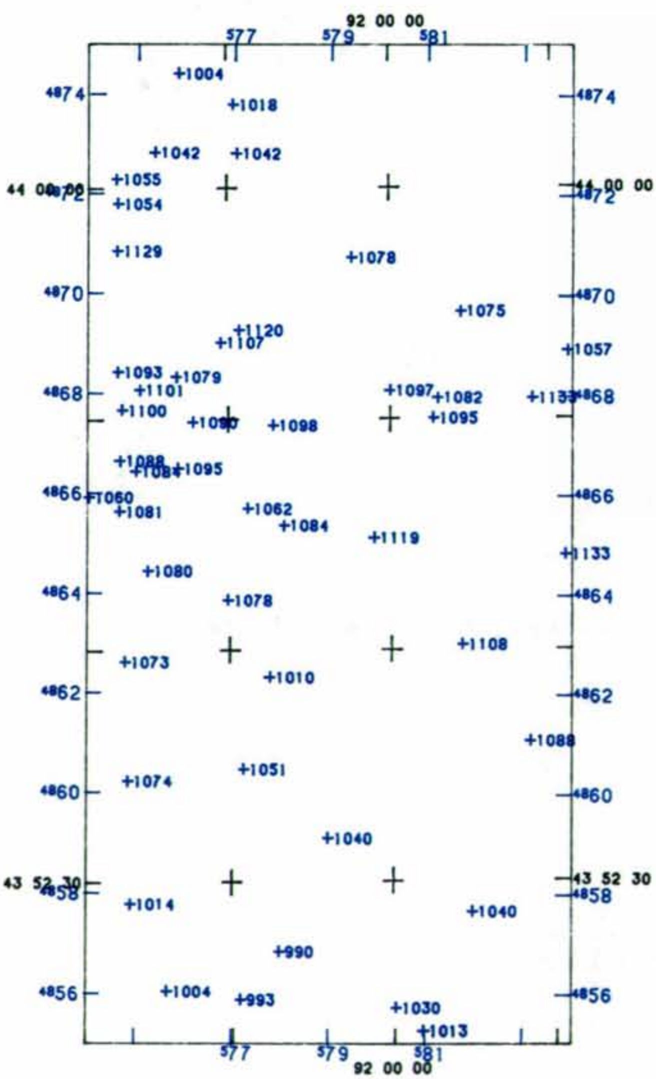
Using Maps to Present Ground-Water Information

Maps are a medium for showing information that often generates interest on the part of the user. People tend to be fascinated by maps and look first for their neighborhood relative to the information presented on the map. However, maps may have a drawback in that the general public tends to assume that maps are always correct and that once prepared, they need never be compiled again. Using maps to portray ground-water information must include public education as to their proper use and limitations for addressing questions.

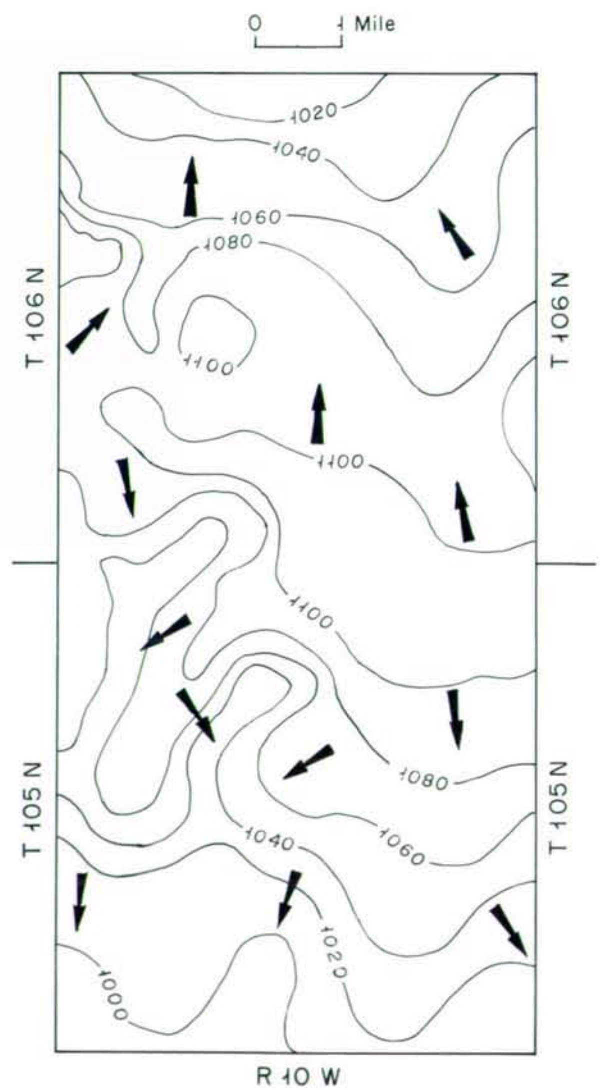
Maps are only as accurate as the data and the technical interpretations used to compile them. Data bases containing adequate amounts of high-quality information are essential for compiling accurate and meaningful maps. The data must be readily accessible to support mapping interpretations, and data collection must be carefully keyed to geographic location. It is important to recognize that maps represent interplay between data and interpretation. Abundant good data, ineptly interpreted, will result in a bad map. Local and state experts must communicate to ensure that interpretations of data are correct for local conditions and are scientifically accurate. This would eliminate outmoded or inaccurate terminology and concepts, ensure that all available information will be utilized, and provide a mechanism to develop the most appropriate and useful ways to present data in map form.

DATA DISPLAY VERSUS DATA INTERPRETATION

Computer plot of static water-level elevations for two townships in Winona County (data from well records and field measurements).



Map showing directions of ground-water movement interpreted from the computer plot (contours show equal potential, arrows show directions of movement).



Data plots generally have a limited interpretive use, even in map display, and usually must be manipulated to produce map units. Technical expertise will usually be required to generate and to explain the results interpreted from data plots. Additional data collection may be needed to test the accuracy of interpreted results.

Conflicts between historical data and new data may require data base editing, as may conflicts between data from different sources. Procedures must be developed to edit data in a coordinated and accurate manner for use as mapping information. Editing should eliminate different interpretations of the same information and corresponding map output, and ensure uniformity of data accuracy between state level and local level data bases.

Often, a single data plot cannot show all of the parameters that must be considered or the complexity of the entire hydrologic system. Most types of data, such as water well records or scientific studies, document information about a single aquifer system. In many areas, data are available for only the ground-water resources nearest the land surface. State programs for describing and monitoring deep aquifer systems have barely begun.

Many studies describe aquifer characteristics for only short periods, which offer little opportunity to determine long-term trends. Multiple data plots from the same sites are required for trend analysis. Data collected at different sites and at different times, even within an area as small as a township, result in a lack of data uniformity and consistency of measurement.

The concept of having all of the data all of the time may not always be the most effective approach to understanding ground-water conditions and the impacts that land use and water use may have on them.

Comments about Ground-Water Data Systems

The first step in assembling and using ground-water information is to determine the types and amounts of data required to address a problem. The concept of having all of the data all of the time may not always be the most effective approach to understanding ground-water conditions and the impacts that land use and water use may have on them. The following general concepts must be considered when designing and using ground-water information systems.

Realize the relationship between data needs versus data availability and data quality. Data needs are derived from questions concerning ground-water management. They may not remain constant over long periods of time because:

- New questions may arise, or ways of thinking about the data may change.
- Sufficient data may be collected to satisfy a need.
- New data may make historical information obsolete.
- The more site-specific water issues become, the greater the need for more detailed information.
- Data availability is usually inversely proportional to data need (Murphy's Law).

Consider how data should be applied to answer a question concerning ground water. State agency staff and/or local personnel may have expertise to answer the question through in-house information or through experience in working with that facet of ground-water problems. Whether data are of sufficient quantity and quality to address an issue depends on the scale at which the issue is being considered and whether the issue is educational or regulatory. The usefulness of data may be directly related to the manner of presentation, such as technical versus interpretive portrayal; density versus quality of data; and filing systems geared to specific data needs.

Using Ground-Water Data Collected by the State

A variety of publicly funded organizations are responsible for collecting and maintaining data relating to ground water, including the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources, the Minnesota Geological Survey, the Water Resources Division of the U.S. Geological Survey, the Land Management Information Center of the State Planning Agency, the Minnesota Department of Health, the Soil and Water Conservation Board, Soil and Water Conservation Districts, the Minnesota Department of Agriculture, the Minnesota Department of Transportation, and others. Some of these organizations maintain their data in computerized (automated) data bases, while others rely on paper (manual) files. This discussion will focus on those organizations which maintain automated data. While computerized data bases do not encompass all available data, they provide the most rapid and convenient access to the data. The State Planning Agency is a good source for determining what other types of data are available in addition to automated data, and has prepared a data catalog listing these sources.

Agency Roles

The Land Management Information Center at the State Planning Agency is a data clearinghouse, which serves in part as a respository for data of value for resource planning, and makes the data compatible for a number of users. The System for Water Information Management (SWIM) links the users of water data with the organizations that collect and store the data. SWIM promotes coordination, data compatibility, and data transferability between individual computerized data bases through the use of common geographic identifiers for the data and compatible formats. The SWIM coordinator, a staff member of the Land Management Information Center, can assist in matching data needs with sources of data.

Ground-water ***quality*** data are primarily collected and maintained by the Minnesota Department of Health, the Minnesota Pollution Control Agency, and the Water Resources Division of the U.S. Geological Survey. Data are collected from wells in an ambient (natural) water quality network and from specific investigations. Ground-water ***quantity*** data are primarily the responsibility of the Minnesota Department of Natural Resources and the Water Resources Division of the U.S. Geological Survey. Ground-water use is monitored through the Minnesota appropriation permit system, in which major users of ground water are regulated and must report pumpage annually. The Minnesota Department of Natural Resources, the U.S. Geological Survey, and the Soil and Water Conservation Districts maintain a network of water-level observation wells around the state. State and federal funding is used cooperatively to conduct regional studies for assessing ground-water availability and aquifer characteristics.

The Water Resources Division of the U.S. Geological Survey conducts hydrologic studies relating to the occurrence, movement, and quality of ground water. These studies are at various scales, from regional aquifer studies to smaller site investigations, and are available in published reports.

The role of the Minnesota Geological Survey is to define and provide information on the geologic characteristics of the state which form the basis for ground-water investigations. The Minnesota Geological Survey collects and maintains files of water-well contractors' records from wells drilled throughout the state. These are a primary source of geologic data. The Survey also conducts geologic research and mapping at various scales, and provides this information either from staff expertise or from publications.

Data Storage and Retrieval

Ground-water information collected and stored by state agencies exists in a variety of forms and filing systems. Obtaining access to this public information and whether it is applicable to planning depend on the following factors, all of which should be evaluated before time and funds are committed.

Automated data bases are useful, but have limitations.

- They may be limited to main-frame computer systems in St. Paul, which may be expensive to access and may require programming skills to operate.
- Many are updated on a quarterly or yearly basis and do not contain all current information.
- Data entry is determined by agency priorities and/or legislative mandate, and data elements may not always be applicable to local needs.
- Data output procedures may not be well documented or may not present the data in a format useful for local planning.
- Historical information, some only just a few years old, is not available on some recently developed computer systems.

Manual filing systems require patience and time to access.

- Some paper files are arranged by program numbering schemes rather than by geographic coordinates.

Computers make shorter work of manipulating ground-water data.

- Some are divided into "in-office active files" and "archived files," which may not even be in the same building.
- Forms for reporting data vary through time, making them cumbersome to interpret, as well as time consuming and costly to copy.

State agencies vary in their ability to provide information.
Some data will not be adequate to address local concerns because of a lack of accessibility, completeness, or accuracy. A number of agencies have severely limited staff resources.

Some agencies may have so much information that obtaining summary files is more realistic than copying the entire data base.

Agencies differ in their purpose for collecting data. They also differ in their internal structure for providing data because of legislation or regulations governing the transfer of agency data to the public or differences in methods of data acquisition.

Development of data systems by state agencies is a process of constant change. Data automation is still rapidly expanding as new methods and technologies appear and new types of data are collected. Agencies are now realizing the importance of data management to regulatory administration, although data base development is directly related to funding levels and is usually the first to go during spending cuts.

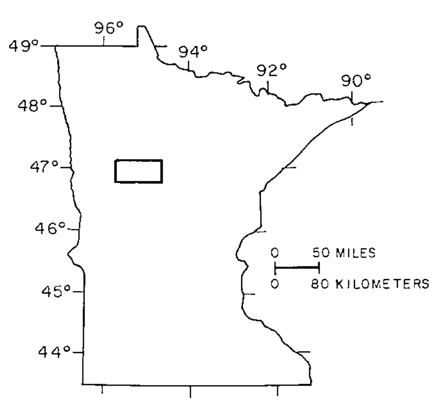
Reasons for data acquisition are changing, affecting the ways data are stored and displayed. Historically, most ground-water data collection and entry have been project related rather than program related. This is changing as more interaction between state and local planners is required. Fixed formats for storing data are being developed, although data access and output procedures may vary according to agency needs through time.

Computerized Ground-Water Data Bases

The ground-water data collected by the State of Minnesota are increasingly maintained on computerized data bases, although even the agencies that make the most use of computerized data bases have not automated all of their data.

To illustrate the types of output from agency computer systems, a demonstration area was chosen which includes parts of Hubbard, Becker, Wadena and Cass Counties in north-central Minnesota. This demonstration will:

- Describe the computerized data bases that store and display ground-water information.
- Show the distribution of computerized data from selected data bases within the area. These are the data bases that are easily accessible.
- Present sample output from selected data bases.



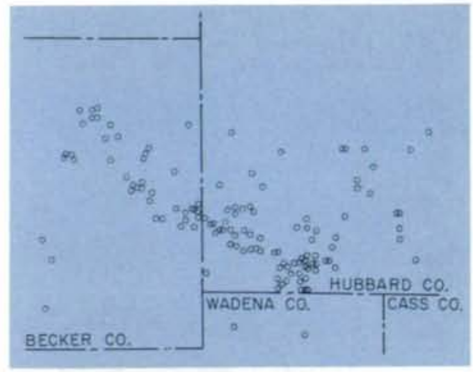
Location map of the demonstration area (shaded).

SWUDS (Statewide Water Use Data System)

SWUDS was developed by the Minnesota Department of Natural Resources in conjunction with the Water Resources Division of the U.S. Geological Survey and the Land Management Information Center. The data base includes ground-water use information from Department of Natural Resources appropriation permits. The information includes:

- unique well number (a six-digit identification number assigned to a water well by the Minnesota Geological Survey)
- geographic location (by township, range, section, subsection)
- water source (aquifer)
- use type (irrigation, industrial use, etc.)
- annual and monthly pumpage volumes.

Information is available for approximately 7000 water appropriators. SWUDS is maintained in an INFO data base.



Data plot showing the distribution of ground-water appropriation permits in the demonstration area; produced from SWUDS data.

				REPORTED PUMPAGE				
PERMIT/INST	LOCATION	USE	DEPTH	81	82	83	84	85
6513011	1383336CD	90	0	0.0	0.0	0.0	0.0	0.0
8231511	13834 4BAC	90	0	0.0	0.0	0.0	0.0	21.3
8532201	13834 5A	90	0	0.0	0.0	0.0	0.0	0.0
7736121	1383426BCDA	90	0	0.0	0.0	0.0	0.0	0.0
8031051	1383522BCDA	11	0	0.0	7.7	14.8	0.0	34.9
7713421	13838 9CCC	90	157	12.0	3.5	0.0	0.0	0.0
7812521	13932 5CAAA	90	81	0.0	0.0	16.6	10.5	6.7
8210472	1393216ADA	85	0	0.0	0.0	0.0	0.4	4.3
821047A	1393216ADA	85	0	0.0	0.0	0.0	0.0	0.0
8210473	1393216ADB	85	0	0.0	0.0	0.0	7.6	3.6
821047D	1393216ADB	85	0	0.0	0.0	0.0	0.2	0.0
8210475	1393216B	85	0	0.0	0.0	0.0	5.0	3.0
8210474	1393216BAD	85	0	0.0	0.0	0.0	6.7	5.1
8210471	1393216DAB	85	0	0.0	0.0	0.0	3.9	0.5
7717051	13933 5CBCC	90	71	0.0	0.0	0.0	0.0	0.0
7931681	13933 7BBD	90	0	0.5	3.4	4.6	0.0	2.2
7912041	13933 7DACC	90	198	0.0	21.9	12.0	8.3	0.0

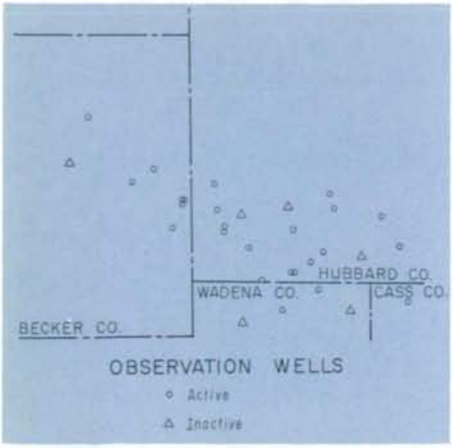
Example of output produced by SWUDS for wells covered by appropriation permits in part of the demonstration area. Documentation on the output is available from the Department of Natural Resources.

GWSI (Ground Water Site Inventory)

GWSI was developed by the Water Resources Division of the United States Geological Survey and is primarily intended to store geologic, well-construction, and water-quantity (water-level) data. The data base is primarily used on a project-by-project basis. Information in the system includes:

- site location and identification
- well construction data
- pumping data
- geologic data
- aquifer data
- water-level data
- on-site analyses of water quality.

Data currently in the system are from U.S. Geological Survey monitoring wells, Minnesota Department of Natural Resources observation wells, and from a variety of ground-water investigations. While the data are available for other users, there is no funding available to include uniform coverage of Minnesota or input of data from other sources. GWSI is maintained on computer systems in both Reston, Virginia, and St. Paul (Minnesota data).



Data plot showing the distribution of observation wells in the demonstration area.

OBWELL (Observation Well System)

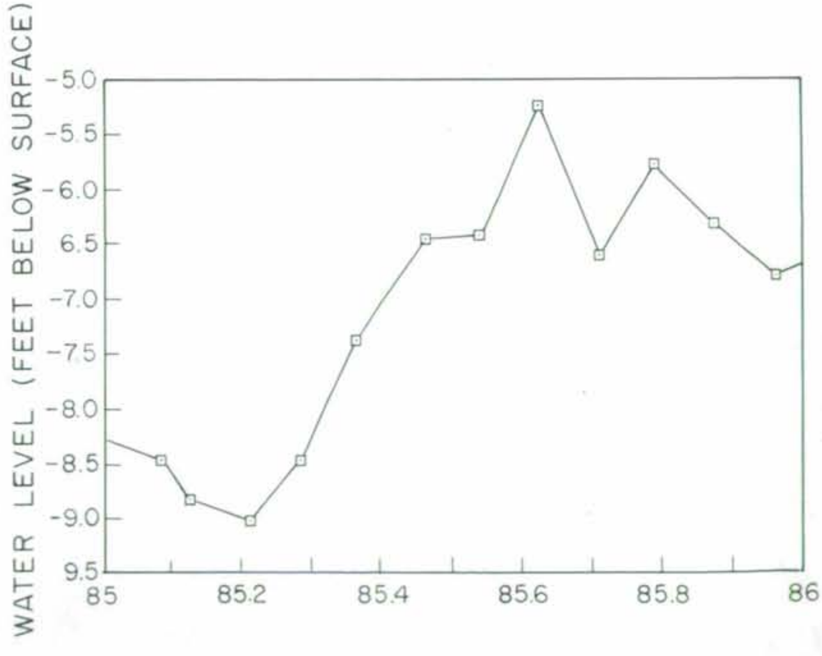
OBWELL is a water-level data base developed by the Minnesota Department of Natural Resources in conjunction with the U.S. Geological Survey and local Soil and Water Conservation Districts. The information contained in the data base includes:

- geographic location (by township, range, section, subsection)
- unique well number
- historic water level readings
- well construction (depth and size of casing, screened interval)
- stratigraphy (geologic formations encountered in drilling)
- aquifer
- status (whether well is actively measured, and how often).

OBWELL contains data from 611 active and 685 inactive observation wells. OBWELL is maintained in an INFO data base and is also available for use with a personal computer.

WELL#	TWP	RNG	SEC	QQQQ	DEPTH	AQUIFER	ACTIVE	PERIOD.S	PERIOD.E
3005	140	36	26	AAD1	28.0	QWTAQWTA	6	10/24/74	/ /
3006	139	36	2	CCC1	15.5	QWTAQWTA	1	10/18/74	/ /
3007	140	36	9	BBA	25.0	QWTAQWTA	1	10/18/74	/ /
3008	140	38	1	DBA	14.2	QWTAQWTA	6	10/18/74	12/21/78
3009	141	37	17	AAA1	34.9	QWTAQWTA	1	10/18/74	/ /
3010	141	37	34	DDD1	25.0	QWTAQWTA	6	10/18/74	11/14/82
3122	140	36	26	AAA	57.0	QBAAQBAA	1	5/17/84	/ /
3123	140	36	25	BBD	89.0	QWTAQWTA	1	5/18/84	/ /
3124	140	36	26	DAA	66.0	QWTAQWTA	1	5/17/84	/ /
3125	140	36	36	AAA	110.0	QBAAQBAA	1	5/17/84	/ /
3126	140	37	13	ADD	38.0	QWTAQWTA	1	/ /	/ /
29000	139	32	16	AAA1	21.0	QWTAQWTA	2	9/03/70	/ /
29001	139	34	26	CCD	22.5	QWTAQWTA	1	11/05/74	/ /
29002	140	33	28	CAB	34.0	QWTAQWTA	1	11/11/74	/ /
29003	139	33	17	CCC	41.5	QWTAQWTA	1	10/17/74	/ /
29004	139	33	24	BBB	35.8	QWTAQWTA	6	10/17/74	5/15/79
29005	139	34	2	CBC	46.0	QWTAQWTA	1	10/17/74	/ /
29006	139	34	32	CBD	30.5	QWTAQWTA	1	10/18/74	/ /
29007	139	35	13	DAD1	52.0	QWTAQWTA	1	10/18/74	/ /
29008	140	32	32	BBA1	25.5	QWTAQWTA	1	10/17/74	/ /
29009	140	33	20	AAA	53.5	QWTAQWTA	1	10/17/74	/ /
29010	140	34	27	ACC	41.0	QWTAQWTA	6	7/08/75	11/15/76

Sample output from OBWELL listing observation wells in the demonstration area by unique number, location (township, range, section, and subsection), depth, aquifer, frequency of measurement, and period of record. Documentation for interpreting the output is available from the Department of Natural Resources.



Hydrograph showing 1985 water levels in well 3006 in the demonstration area, generated from OBWELL data.

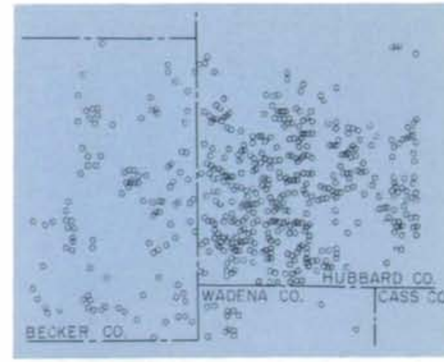
WELLS (Well Log Listing System)

WELLS is an index of drillers' logs developed jointly by the Minnesota Geological Survey and Minnesota Department of Natural Resources. The data base contains summary information from well-drillers' logs and includes:

- geographic location (by township, range, section, subsection)
- unique well number
- depth
- well construction
- static water level
- aquifer
- limited geologic information.

The information is currently available for approximately 90,000 wells throughout the state. WELLS is maintained by the Department of Natural Resources using an INFO data base and is also available for use with a personal computer through the Minnesota Geological Survey.

WELLS contains a large number of data points, but contains only limited information for each well. For example, in the demonstration area, over 900 wells are listed in the data base. However, only a fraction of these wells had their locations verified and their drillers' logs interpreted by geologists.



Data plot showing the distribution of wells in the demonstration area, for which data are contained in the WELLS data base.

UNIQ#	TWP	RNG	SECT	QQQQ	DEPTH	AQUIFER
222190	139	36	1	B	260	
222191	139	36	1	BABB	80	QWTA
118435	139	36	3	BCAA	46	QWTA
222199	139	36	10	DAAC	19	
222189	139	36	12	AAAD	76	QBAA
109243	139	36	16	CCCA	49	QBAA
222138	139	36	16	ADBD	36	QBAA
132613	139	36	18	AAAD	90	QBAA
222139	139	36	20	ABAD	72	QBAA
153335	139	36	33	CBBB	32	QBAA

WELLS output listing all records within Green Valley Township by unique well number, location (township, range, section, and subsection), depth, and aquifer.

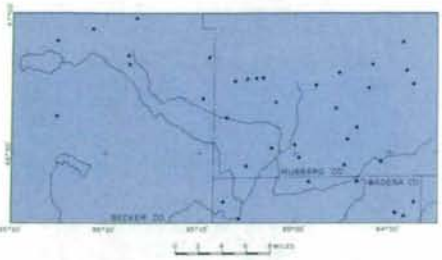
```
ID NUMBER  :
MGS UN.NO  : 100877           NAME : AUDUBON DEVELOPMENT
  PERMIT NO:                  USE  : PUBLIC SUPPLY
  COUNTY   : BECKER           DEPTH:  185 FT.
  T/R/SEC. : 139/42/15BDCA    CASED:  167 FT.   CASING :
  ELEVATION: 1313 FT.         DIAM.:    8 IN.   AQUIFER: QUAT.
  DRILLED  : 78/10/02         GROUT:        YDS.   BURIED ARTES. AQUIFE
  OPEN HOLE: QUAT. BURIED ARTES. AQUIFER-QUAT. BURIED ARTES. AQUIFER
  QUAD     : AUDUBON
  POTENTIAL POLLUTION SOURCE :  100 FT.

      DATE    NITRATE  BACTERIA   SOURCE          SWL  ELEV   SOURCE
    --------  -------  --------  -------         ----  ----  -------
    78/10/02                                        6  1307
```

WELLS output for a well in the demonstration area.

IGWIS (Integrated Ground Water Information System)

IGWIS is being developed by the Minnesota Pollution Control Agency with assistance from the Land Management Information Center. The data base is a comprehensive system for the Minnesota Pollution Control Agency to better utilize its ground-water quality data and other related information such as well use, well construction, and stratigraphy. All ground-water quality sampling sites are intended to become part of this data base. IGWIS will be stored on an INFO data base at the Land Management Information Center.



Data plot showing the distribution of wells in the demonstration area for which there are data in STORET. This type of plot is available through the Minnesota Pollution Control Agency.

STORET (Storage and Retrieval)

STORET is a computerized system developed by the U.S. Environmental Protection Agency for storing water-quality and water-related information. The system includes information on:

- station identifiers
- site location (by latitude/longitude)
- ground-water quality analyses
- surface-water quality.

Data on water quality come from samples collected by state and federal agencies. STORET data for Minnesota are accessed by the Water Quality Division of the Minnesota Pollution Control Agency. These data are stored at the U.S. Environmental Protection Agency national computer center in Research Triangle Park, North Carolina. The data base contains detailed information for each point, but contains a limited number of points. In the demonstration area, data for only 50 wells are available in STORET.

Data plots are available through the Minnesota Pollution Control Agency, but are actually plotted at the Environmental Protection Agency headquarters in Washington, D.C. Printed output from STORET is available directly from the Minnesota Pollution Control Agency.

PARAMETER				MEDIUM	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	WATER	2	125790.0	.0000000	.0000000	125790	125782	84/05/16	84/05/16
00010	WATER	TEMP	CENT	WATER	2	8.700000	.0801090	.2830400	8.9	8.5	79/08/21	84/05/16
00080	COLOR	PT-CO	UNITS	WATER	1	15.00000			15	15	79/08/21	79/08/21
00094	CNDUCTVY	FIELD	MICROMHO	WATER	2	489.0000	1458.000	38.18400	516	462	79/08/21	84/05/16
00095	CNDUCTVY	AT 25C	MICROMHO	WATER	1	500.0000			500	500	79/08/21	79/08/21
00136	SAMPLE	TEMP AT	LAB DEGC	WATER	1	1.000000			1.00000	1.00000	84/05/16	84/05/16
00400	PH		SU	WATER	2	7.350000	.0049744	.0705290	7.40	7.30	79/08/21	84/05/16
00403	LAB	PH	SU	WATER	2	7.500000	.0199890	.1413800	7.6	7.4	79/08/21	84/05/16
00410	T ALK	CACO3	MG/L	WATER	2	265.0000	50.00000	7.071100	270	260	79/08/21	84/05/16
00425	HCO3 ALK	CACO3	MG/L	WATER	2	265.0000	50.00000	7.071100	270	260	79/08/21	84/05/16
00431	T ALK	FIELD	MG/L	WATER	2	275.0000	450.0000	21.21300	290	260	79/08/21	84/05/16
00505	RESIDUE	TOT VOL	MG/L	WATER	1	150.0000			150	150	79/08/21	79/08/21
00615	NO2-N	TOTAL	MG/L	WATER	1	.0100000			.010	.010	79/08/21	79/08/21
00625	TOT KJEL	N	MG/L	WATER	1	.7900000			.790	.790	79/08/21	79/08/21
00630	NO2&NO3	N-TOTAL	MG/L	WATER	1	.0100000			.01	.01	79/08/21	79/08/21
					1	.0100000			.01	.01	84/05/16	84/05/16
					2	.0100000	.0000000	.0000000	.01	.01	79/08/21	84/05/16
00665	PHOS-TOT		MG/L P	WATER	1	.1000000			.100	.100	79/08/21	79/08/21
00680	T ORG C	C	MG/L	WATER	1	2.000000			2.0	2.0	79/08/21	79/08/21
					1	1.000000			1.0	1.0	84/05/16	84/05/16
					2	1.500000	.5000000	.7071100	2.0	1.0	79/08/21	84/05/16
00900	TOT HARD	CACO3	MG/L	WATER	2	260.0000	200.0000	14.14200	270	250	79/08/21	84/05/16
00910	CALCIUM	CACO3	MG/L	WATER	2	185.0000	50.00000	7.071100	190.0	180.0	79/08/21	84/05/16

STORET data for a well in the demonstration area. This format is one type of summary format available from STORET. Documentation for interpreting the output is available from the Minnesota Pollution Control Agency.

WATER QUALITY DATA

ALKA- LINITY WH WAT TOTAL FIELD MG/L AS CACO3 (00410)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N) (00608)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N) (00631)
349	0.01	9.70

Sample output from WATSTORE for a well in the demonstration area.

WATSTORE (Data Storage and Retrieval System)

WATSTORE is a system to store and retrieve all water data generated by the U.S. Geological Survey. Information in the system includes:

- station identifiers
- location (by latitude/longitude and township, range, section)
- ground-water quality analyses
- surface-water quality analyses.

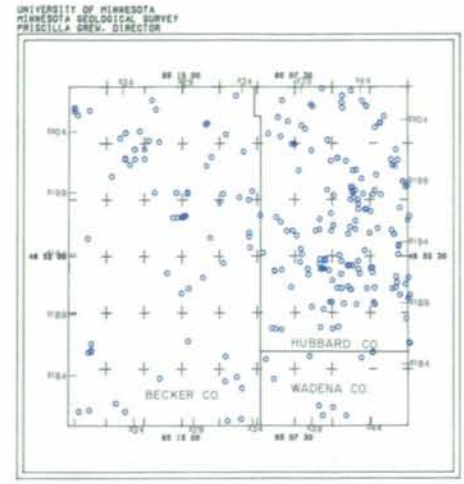
Minnesota data are maintained at the Water Resources Division office in St. Paul, and are periodically updated to their national system in Reston, Virginia. WATSTORE data are updated monthly to STORET, so that in principle all water-quality data in WATSTORE are contained in STORET.

WELLOG (Water Well Data Base)

The Water Well Data Base or WELLOG was developed by the Minnesota Geological Survey for storing detailed information from well-drillers' logs. It contains information on:

- unique number
- location (by UTM coordinates, township, range, section, topographic quadrangle map)
- well construction details
- stratigraphy
- geologic interpretations.

The wells in this data base have been field located, and their locations have been digitized on topographic quadrangle maps. The drillers' logs have been interpreted by geologists. Fewer well records are represented than in the WELLS data base, but there is much more detailed and accurate information for each well. It currently contains about 30,000 records and is maintained on a System 2000 data base at the Computer Center at the University of Minnesota. It is accessible through the Land Management Information Center.



Distribution of WELLOG data in a portion of the demonstration area.

```
MINNESOTA GEOLOGICAL SURVEY
WATER WELL DATA BASE.
   UNIQUE NO.: 100877
   WELL NAME : AUDUBON DEVELOPMENT CORP

   COUNTY     : BECKER                    DATE ENTERED:  86/03/20.
   ADDRESS    :                                  AUDUBON
   QUADRANGLE: AUDUBON 7.5 MINUTE

   TOWNSHIP   : 139 NORTH                 UTM-EASTING : 272972
   RANGE      :  42 WEST                  UTM-NORTHING: 5193357
   SECTION    :  15/BDCABB                UTM-ZONE    : 15
   LATITUDE   : 46:51:25 N                LONGITUDE   : 95:58:41 W
   LOCATED BY: PLAT BOOK

   ELEVATION : 1313 FT.                   WATER LEVEL :   6 FT.  (EL.1307 FT.)
   DEPTH     :  185 FT.                   DATE        : 78/10/02
   COMPLETED : 78/10/02                   AQUIFER(S)  : QUAT. BURIED ARTES. AQUIF

   WELL USE   : PUBLIC SUPPLY
   DRILLER    : (AND/OR DATA SOURCE) KRUEGER WELL CO.
     LIC. NO.:  03034
   CASING     : STEP DOWN
              :   8 INCH TO   167 FEET

              SOURCE OF POSSIBLE CONTAMINATION                    DRILLER'S  DESCRIPTION
              FEET:    100 DIRECTION: NORTH TYPE: SANITARY SEWER  ------------------------
   SCREEN                                                         BLACK DIRT
    MAKE/TYPE: JOHNSON            STAINLESS STEEL                 CLAY
    DIAMETER :      8 IN.            LENGTH     :  19.6 FT.       CLAY + ROCK
    SETTING  :  167 FT. TO   185 FT.  SLOT/GAUZE :  12            COARSE SAND
                                                                  CLAY
   PUMP                                                           SANDY CLAY
    MAKE/NO. : DEMING                                             WATERSAND
    SIZE     :      15 HP.   440 VOLTS  CAPACITY    :   100 G.P.M. ------------------------
    TYPE     : NON-STANDARD             DROP PIPE   :   108 FT.

   REMARKS    : PUMPAGE TEST DATA NOT AVAILABLE
--------------------------------------------------------------------------------

                             GEOLOGIC LOG
--------------------------------------------------------------------------------
 DEPTH
INTERVAL                                 STRATIGRAPHIC UNIT
(IN FEET) LITHOLOGY                      SYSTEM/GROUP/FORMATION     AGE HARDNESS COLOR
--------------------------------------------------------------------------------
   0     2 SOIL,ORGANIC                  RECENT DEPOSIT             REC          BLACK
   2    27 CLAY                          BROWN TILL                 QUA          YELLOW
  27    68 CLAY,COBBLE                   GRAY TILL                  QUA          BLUE
  68    73 SAND                          FLUVIAL DEPOSIT            QUA
  73   141 CLAY                          GRAY TILL                  QUA          BLUE
 141   167 CLAY,SAND                     TILL                       QUA
 167   185 SAND                          FLUVIAL DEPOSIT            QUA
--------------------------------------------------------------------------------
```

Example of WELLOG output.

Developing Ground-Water Data Bases for Local Use

Establishing a storage and retrieval system capable of providing ground-water data for planning entails a planning process of its own, if pitfalls are to be avoided. In the past, many data management systems initiated at the state and federal level have failed, because no assessment of possible additional applications in the future was made. The costs of long-term operation also need to be considered. A usable data management system does not require "state-of-the-art" equipment to function, nor does it need to be excessively expensive to use. However, to succeed, it needs to be flexible, simple, and practical.

A usable data management system does not require "state-of-the-art" equipment to function, nor does it need to be excessively expensive to use.

Data bases should be designed to take advantage of data already computerized by state agencies. Local data systems need not contain the same types or amount of data required at the state level. However, common data types should be transferable between local and state decision makers for common access to available information. Common geographic locators and unique identifiers for specific data sites make it possible for state and local systems to interact. A regional data base is preferable to individual county versions, because it reduces the number of data base structures with which state agencies, such as the Land Management Information Center, must interact. It may also improve communication between counties when working on regional ground-water issues, permit less extensive documentation of file structures, and shorten training of county staff.

The more a data system is used, the broader its capabilities will have to become. Initially, it may be used solely for storage and retrieval, but statistical capabilities will be required for staff to use it to interpret data. Different combinations and/or interpretations of the same information may be required to evaluate different problems. Periodic review of data system capabilities will ensure that the system continues to serve local needs.

Data base development should keep usability and simplicity as major design considerations. Simplicity of design makes data entry and output procedures easier to learn and will probably reduce operating costs. Multiple files, each containing a unique key data set, are less expensive to access and maintain than a single file holding all types of data. The easier a data management system is to operate, the more likely it will be used by local staff. Personal computers provide a very effective means of establishing and maintaining automated data bases at relatively small cost. Manual files provide effective data storage and retrieval if properly maintained.

Existing filing structures used by the System for Water Information Management (SWIM) may eliminate the time and expense required to develop local data management systems. These structures may need to be altered to store data needed locally, but they are already paid for and have agency staff who are responsible for maintenance and update. This system may be available at agency regional offices or local offices, such as the Agricultural Extension Service of the University of Minnesota.

Procedures for Ground-Water Evaluation

The two major categories of questions concerning our ground-water resources were discussed earlier. This section introduces procedures to address the second category of questions, which require data analysis and interpretation. Realistically, many of these questions may have only partial answers because of insufficient data and lack of time or resources for collecting additional data. However, a systematic approach to addressing this type of question provides for the most knowledgeable and efficient means of utilizing available information.

The complexity of ground-water resource questions is related to a combination of local geologic and hydrologic conditions, land and water uses over time, rules and regulations governing water, and public perception of a problem. All of these factors must be reviewed during the planning process. Legal, social, and economic factors are beyond the scope of this report, but must also be considered when making water management decisions.

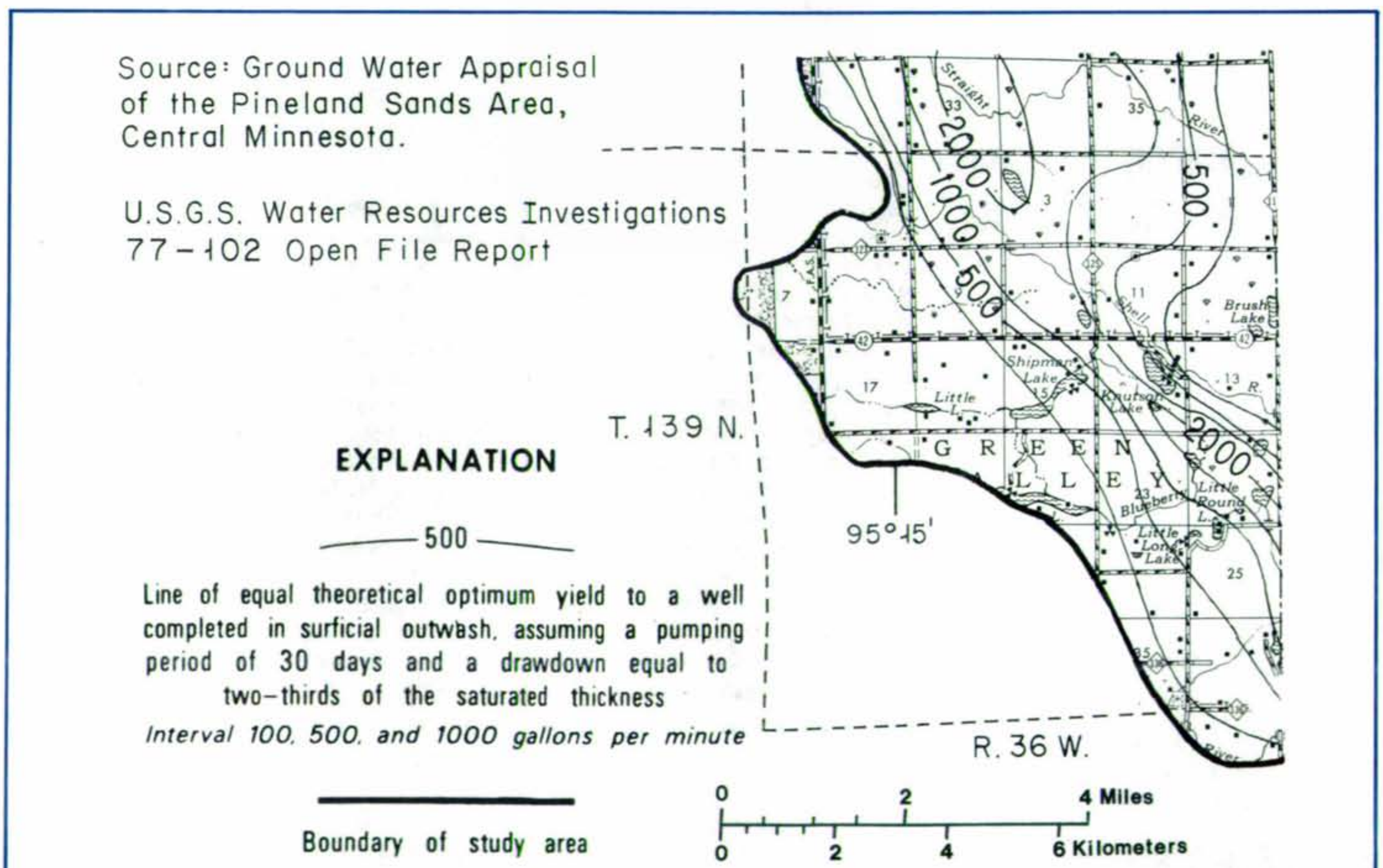
The *first step* in answering a question is to state it clearly and to determine its significance relative to local water management policy (i.e., is it really worth answering).

Example question: *How much ground water is available in our township?*

Significance of the question: Knowing the limitations of available ground-water resources enables the public to plan for its wise use on the basis of local and state priorities. Knowledge of resource capabilities will reduce water-use conflicts that arise either from poorly planned siting of wells or from wells not drilled deep enough to compensate for the effects of water-level fluctuations caused by pumping. Furthermore, this knowledge will enable design and construction of high-capacity wells to draw water with minimum impact to the aquifer.

The *second step* is to determine if maps or reports are available that can directly answer the question. Generally, the larger the scale of a study, the more likely it may circumvent the need to compile site-specific information into interpretive form, as well as enable technical staff to prepare interpretive materials more efficiently.

Example: Part of Green Valley Township in Becker County was investigated by a sand-plain aquifer study that was jointly funded by local residents, the Water Resources Division of the U.S. Geological Survey, and the Division of Waters of the Minnesota Department of Natural Resources. The illustration shows the theoretical well yields calculated for this aquifer.



Ground-water availability from a sand aquifer, Green Valley Township, Becker County (Ground-water appraisal of the Pineland Sands area, central Minnesota; U.S. Geological Survey Water-Resources Investigations Open-File Report 77-102).

Technical expertise was required to prepare the map because a variety of geologic and hydrologic factors were considered. The map can be used for:

- estimating the availability of ground-water resources and answering at least part of the example question
- locating new high capacity wells in relation to the maximum aquifer yield potential
- delineating the boundaries of the aquifer system.

The *third step* is to determine what information a map or study cannot provide and what means are available to complete the answer to a question.

The map shown has limitations. It does not cover the entire township because the near-surface sand aquifer is absent in some areas. Also, it does not describe yield potential for aquifers that may exist below the sand aquifer.

When studies are incomplete or unavailable, other sources of data must be explored, such as data bases that would provide the information needed to prepare a satisfactory interpretation, or state agency staff assistance in acquiring additional information.

The *fourth step* is to develop and implement a plan to obtain the additional information required to answer the question. Any proposed plan should be reviewed by state agencies, because outside review may enhance the quality of the work plan and matching public funds may be available for assistance. In addition, this review ensures that data generated will be useful for any state review of project results.

Evaluating and Using Site-Specific Data

Even if large-scale geologic and hydrologic maps are available for a county, many decisions governing the use and protection of ground-water resources must be made on the basis of site-specific information. Intensive and costly studies are required to permit and operate a solid-waste disposal facility, but most water-management decisions involving a specific property do not require this level of detail. Data bases of high-quality information are a tool for making the daily water-management decisions that local staff and officials implement. Maps and reports are the blueprints describing ground-water resources, while data bases are the components used to construct sound water-management programs.

Site-specific information may be the only means that local and state technical staff have for assessing local ground-water conditions and the impacts of land use on ground-water quality. No large-scale geologic and hydrologic maps are available for most of Minnesota, because current data are insufficient. Development of data bases will help produce these maps, as well as permit retrieval of site-specific ground-water information.

The uses of site-specific information to address questions about ground water are so varied throughout the state that it is not possible to show examples of all of them. Instead, a representative example follows, which outlines a possible approach for using such data in the planning process.

Assemble all accessible information and arrange it chronologically.

- Define when various agencies may have been involved so that staff expertise may be called on.
- Identify changes in site conditions that may affect data evaluation.
- Identify trends from parametric information such as water levels or chemical data.
- Outline temporal gaps in the data that may require additional data collection.

DATA DESCRIBING GROUND-WATER RESOURCES AT CITY OF ST. CHARLES WELL 4, WINONA COUNTY.

Geologic data and water-quality analyses stored in a computer data base from the old well (above) and the new well (below). (County Well Index is the working file at the MGS that is entered into WELLS.)

COUNTY WELL INDEX - MINNESOTA GEOLOGICAL SURVEY.

ID NUMBER :
MGS UN.NO : 220517 NAME : ST CHARLES WELL NO4
PERMIT NO: USE : PUBLIC SUPPLY
COUNTY : WINONA DEPTH: 405 FT.
T/R/SEC. : 106/10/19CADD CASED: 304 FT. CASING : STEEL
ELEVATION: 1145 FT. DIAM.: 16 IN. AQUIFER: JORDAN
DRILLED : 74/09/06 GROUT: YES
DPTH BDRK: 38 FT. BEDRK: PRAIRIE DU CHIEN GROUP
OPEN HOLE: JORDAN-JORDAN
QUAD : ST.CHARLES

DATE	NITRATE	BACTERIA	SOURCE	SWL	ELEV	SOURCE
81/09/09	12		MDH			
81/08/10	12		MDH			
81/07/10	12		MDH			
81/06/15	8.6		MDH			
81/05/13	12		MDH			
80/10/14	9.04	0	MNHD			
79/06/19	4.9	0	MNHD			
78/03/01	5.5	0	MNHD			
76/10/14	5.9		MNHD			
76/06/03	4.5		MNHD			
76/02/11	4.7	0	MNHD			
74/09/06				52	1093	27010

COMMENTS: DEEPENED BY 27058 NOW CIGL WELL 161426
CASING: 024 TO 0038;016 TO 0304.

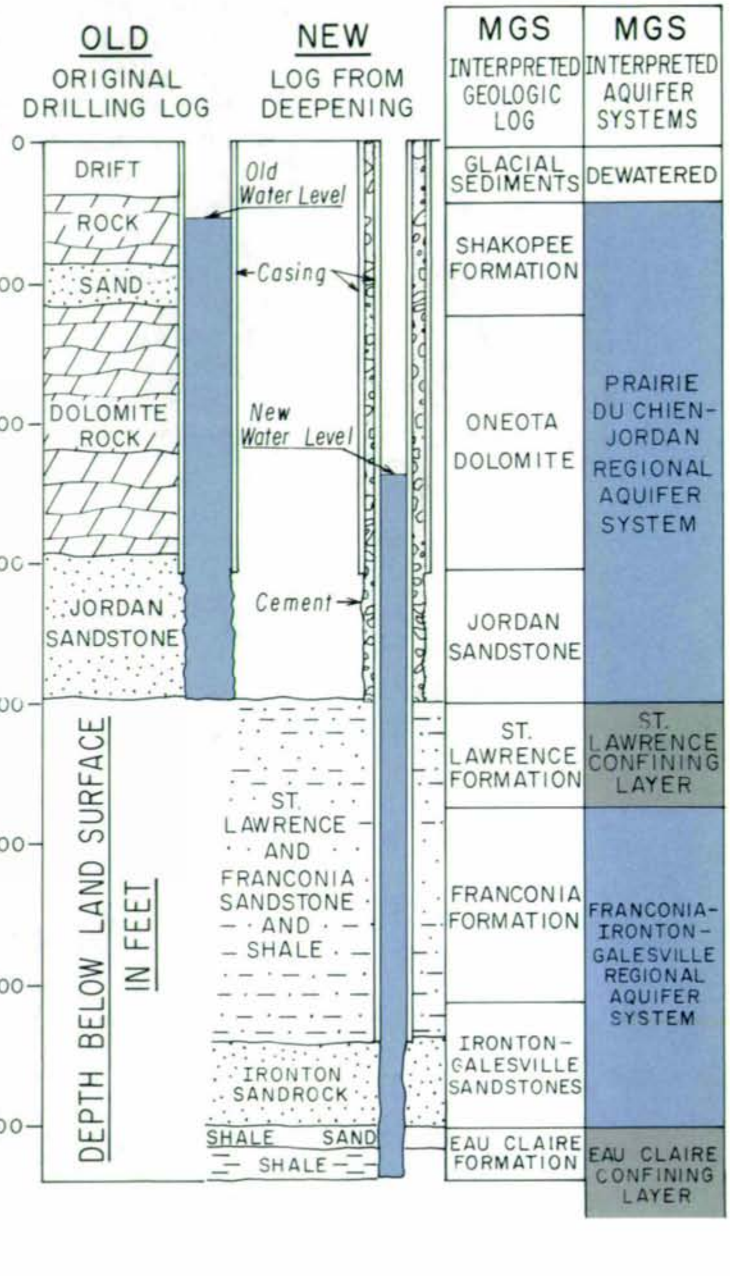
COUNTY WELL INDEX - MINNESOTA GEOLOGICAL SURVEY.

ID NUMBER :
MGS UN.NO : 161426 NAME : ST CHARLES WELL NO4
PERMIT NO: USE : PUBLIC SUPPLY
COUNTY : WINONA DEPTH: 736 FT.
T/R/SEC. : 106/10/19CADD CASED: 648 FT. CASING :
ELEVATION: 1145 FT. DIAM.: 10 IN. AQUIFER: IRONTON-GALESVILLE
DRILLED : 83/03/15 GROUT: YES
DPTH BDRK: 38 FT. BEDRK: PRAIRIE DU CHIEN GROUP
OPEN HOLE: IRONTON-GALESVILLE-IRONTON-GALESVILLE
QUAD : ST.CHARLES

DATE	NITRATE	BACTERIA	SOURCE	SWL	ELEV	SOURCE
86/12/05	<.4		MDH			
85/11/20	<.4		MDH			
84/06/01	<.4		MDH			
83/03/15				238	907	27058

COMMENTS: WELL DEEPENED FORMERLY 220517 DRILLED BY 2710 SEE OTHER REFERENCE
DEEPENING OF ST. CHARLES NO. 4 UNIQUE NO. 220517

Geologic conditions, aquifer characteristics, and well construction; obtained from drilling records and site investigations.



Example: The computer output shown represents data collected from several sources from a municipal well in the City of St. Charles, Winona County. The well was originally drilled in 1974 and used the aquifer closest to the land surface. By 1980, nitrate nitrogen content of the water sampled by the Minnesota Department of Health was approaching the limits set for safe drinking water supplies. In 1983, the well was deepened into the next lower aquifer system as determined from drilling samples, borehole geophysical records, and other data collected and interpreted by the Minnesota Geological Survey. All of this information is stored in a computer file, which in turn feeds data into WELLS.

Interpret the information on local ground-water conditions. The information assembled for this example well shows several important factors concerning local ground-water conditions.

- The two aquifer systems closest to the land surface are hydrologically separated as evidenced by the differences in static water levels reported in the well.
- Ground-water quality in the upper aquifer system is being impacted by land use and appears to be worsening over time.
- Water quality in the deeper aquifer system appears to be unaffected by land use.

Use the information obtained above to ask questions about local ground-water resources. Using the example:

- Are nitrate nitrogen levels as high in surrounding wells using the upper aquifer?
- Are the two aquifer systems hydrologically separated everywhere in the county?
- What is the source of nitrate nitrogen that is contaminating the upper aquifer?
- What other types of contamination may be entering the ground water here?

Apply these questions to the ground-water planning process.

Conclusion

Using ground-water information as a planning tool is a dynamic process. The process is modified when the scale or emphasis on the problem changes and data-base development must be adaptable to these changes in user need. As water planning proceeds from the developmental phase to implementation, data collection must be prioritized. A matrix can be developed that correlates the data types with frequency of use—data types needed most often should receive the highest priority for collection and access. Then the user may choose the most appropriate mechanism to utilize the data, taking into account the ability of the source to provide the data and the ease of interpretation and presentation.

This booklet cannot identify or describe all of the types of data required to answer all ground-water questions; nor can it present a comprehensive methodology, due to the variable nature of ground-water resource questions. Effective planning for ground-water management is the only way to accomplish the needed methodology. This booklet can serve as a reference of major concepts and considerations that planners should evaluate during collection and presentation of ground-water data.

How does ground water become contaminated?

In the air, water vapor is affected by the materials that cause air pollution, and these contaminants fall to earth with the water in the form of rain or snow.

Once on the ground, the water acquires additional substances, such as animal waste, pesticides, and fertilizers. As the water seeps down to the water table, it can dissolve additional waste materials such as those buried in landfills. Once contaminated, an aquifer may remain so for hundreds or even thousands of years.

Improper well construction and abandonment.

Polluted surface water that may cause future problems.

Improper waste disposal or storage.

Pumping contaminated ground water—today's problems were caused long ago.

Latest fashionwear at some sites of ground-water contamination.

What you see is what you get—eventually.

Back cover: Perennial streams receive part of their flow from ground water. During periods of severe drought, all of the flow may originate as ground water.