DEVELOPMENT OF A WATER-USE DATA SYSTEM IN MINNESOTA

By M. A. Horn

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound units	By	To obtain metric unit
inch (in.)	25.40	millimeter (mm)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare (ha)
gallon (gal)	0.003785	cubic meter (m^3)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
million gallons (Mgal)	3,785	cubic meter (m^3)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

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ABSTRACT

The Minnesota State Legislature passed laws as early as 1937 to regulate use of Minnesota's ground water and surface water through a permit system. Several unsuccessful attempts were made to computerize water-use data reported to the State. The U.S. Geological Survey, through the National Water-Use Information Program, assisted the Minnesota Department of Natural Resources and the Minnesota State Planning Agency, Land Management Information Center, in developing MWUDS (Minnesota Water-Use Data System).

The Minnesota Water-Use Data System stores data on the quantity of individual annual water withdrawals and discharges in relation to the water resources affected, provides descriptors for aggregation of data and trend analysis, and enables access to additional data contained in other data bases. MWUDS is stored on a computer at the Land Management Information Center, an agency associated with the State Planning Agency. Interactive menu-driven programs simplify data entry, update, and retrieval and are easy to use. Estimates of unreported water use supplement reported water use to completely describe the stress on the hydrologic system. Links or common elements developed in the MWUDS enable access to data available in other State water-related data bases, forming a water-resource information system. Water-use information can be improved by developing methods for increasing accuracy of reported water use and refining methods for estimating unreported water use.

INTRODUCTION

Legislators, planners, and citizens have become aware of the need for water-resource management to alleviate localized water shortages. The mid-1970's drought in Minnesota focused attention on the need for improved water-resource information for more effective management. In the course of gathering water-use data for the 5-year estimates of water use in the United States, the U.S. Geological Survey became aware of problems in obtaining documented water-use information and established the National Water-Use Information Program to meet these needs. The requirements for the national program caused ongoing State programs to expand from computerizing annual water-use data reported to the State to developing a more comprehensive water-use data system as part of an integrated water-resource information system. At this stage in the development of the water-use system in Minnesota, no distinction is made between water use and water withdrawals; the terms are used interchangeably throughout this report.

Purpose and Scope

The primary purpose of this report is to describe the MWUDS (Minnesota Water-Use Data System) for local and State personnel responsible for water-resource management. Another purpose of this report is to share our experience with managers of other states' water-use programs and provide an example that can be used or modified to meet needs of other states. Discussion of previous water-use data collection and storage activities provides background for understanding how MWUDS was developed by combining the resources of the State with their water-management objectives and the requirements of the National Water-Use Information Program. MWUDS is described in three sections, (1) the basic structure of the data system, (2) the computer software that provides a user-friendly, interactive, menu-driven system capable of providing needed data easily and efficiently through the Land Management Information Center, and (3) the evaluation of stored data consisting of both reported and estimated annual water-use data that can be retrieved on a facility by facility basis. MWUDS is designed to be integrated with other State water-related data bases as part of a water-resource information system. Lastly, the strategy developed to refine the water-use data system through improved data collection and analysis is described.

Previous Water-Use Data Collection and Storage Activities

Regulation of water allocations through a permit system began in 1937 in Minnesota when the State first required permits for water use outside municipal limits (table 1). The need for water-appropriation permits resulted from the severe drought in the midwest United States in the 1930's. At the same time, a public-waters permit program was started to regulate modifications of the course, current, or cross-section of surface-water bodies in the State. These two programs were cross-referenced by a master permit index that contained a summary of each permit.

Table 1.--Chronology of water-use legislation in Minnesota

Year	Legislation summary
1937	The first legislation is passed that regulates activities affecting lakes, streams, and ground water, including dams, reservoirs, and control structures. Permits are required of all water appropriators, except: 1. Those supplying less than 25 people (domestic) 2. Those using water within a municipality 3. Those using water before 1937
1955	MDNR (Minnesota Department of Natural Resources) practice requires annual reporting of water pumped as a condition of each permit issued.

Table 1.--Chronology of water-use legislation in Minnesota--Continued

Year	Legislation summary
1959	Permits are required of all water appropriators, except: 1. Those using water within a municipality before 1959 2. Those using water outside a municipality before 1937
1965	Legislation is passed that: 1. Requires permits for major modifications of water use, such as increased pumping, even for facilities meeting 1959 permit exemptions 2. Requires facility owners to provide information on location, capacity, purpose of water use, or other information specified by the MDNR even if their facilities met the 1959 permit exemptions 3. Authorized the MDNR to examine air-conditioning or industrial-cooling facilities 4. Requires facility owners to provide reports of monthly water use for each year by January 15 even though their facilities met the 1959 permit exemptions 5. Requires facility owners to measure their water use with reasonable accuracy with a flow meter or timing device
1973-74	Legislation is passed that: 1. Initiates fees for permit, water-use report processing, and field inspection 2. Directs the MDNR, in cooperation with other State agencies, to "establish and maintain a statewide system to gather, process, and disseminate information on the availability, distribution, quality, and use of waters in the state" 3. Removes exemptions 1959-1 and 1959-2 4. Broadens 1965-3 to include all uses of water 5. Changes 1965-4, monthly water-use reports are due by February 15 6. Changes 1965-5 to remove the specific references to flow meter or timing devices 7. Requires the establishment of a minimum amount of water that could be appropriated without a permit (determined in 1980 to be less than 10,000 gallons per day or 1 million gallons per year) 8. Added priorities by type of use
1977	Legislation is passed that: 1. Limit the use of surface waters from lakes and streams, and the use of ground-water in certain parts of the state and imposes special reporting requirements in each case 2. Provides for limiting withdrawals from streams to protect low flows for instream use and downstream high-priority uses 3. Provides for limiting withdrawals from water basins (lakes and reservoirs) and establishes protection elevations below which no water could be taken

Subsequent legislative changes to the water-appropriation permit program are highlighted in table 1. By 1955, all water appropriators with permits were required to file annual water-use reports with the MDNR. By 1966, all large users, with or without permits, were required to report pumpage. In 1973, the Legislature eliminated nearly all the previous exemptions from permit requirements, the only remaining exemption was that domestic suppliers for less than 25 people were not required to obtain appropriation permits. Permits and annual-pumpage reports were required from all major self-supplied water users in the State, defined as the equivalent water use of 25 people (determined in 1980 to be 10,000 gallons per day or 1 million gallons per year). As a result, the number of permit applications received by the MDNR increased from 1974 to 1975 by 90 percent (fig. 1). MDNR attempted to assemble, tabulate, and computerize water-use information both in 1965 and 1973. Computerization was not completed due to insufficient in-house data-processing expertise and the high cost associated with designing and implementing a computerized file of water-use data.

Permit applications doubled again from 1975 to 1977 as irrigation increased because of drought conditions in the mid-1970's. From July 1, 1976, to June 30, 1977, 92 percent of applications were for irrigation permits (fig. 2). Increased concern for protecting the State's water resources prompted legislation in 1977 requiring additional information from permit applicants and the protection of low streamflows and lake levels. The State Legislature recognized that water-resource information needed by the MDNR to implement these safeguards had to be accessible along with similar information collected by several other State agencies. To manage the greater volume of data efficiently, a new effort was begun in 1976 to computerize water-use and related water-resource information.

The LCMR (Legislative Commission on Minnesota Resources) provided $100,000 to the MEA (Minnesota Energy Agency) to develop a coordinated water-information system. This system was initially designed to combine data from MDNR, MDH (Minnesota Department of Health), MPCA (Minnesota Pollution Control Agency), Minnesota Geological Survey, and the Minnesota State Planning Agency into one master data base. However, because the agencies involved in the project had different data requirements and priorities, the system design was modified to include several data bases that would meet the needs of each agency. The data base developed by the MEA for MDNR was the 1976 water-use data base. At about the same time, the MDNR developed the irrigation ground-water data base. The software package SYSTEM 2000[a] was used for both data bases because of its versatility and flexibility in formatting retrievals. Computer facilities at the University of Minnesota were used because instruction and documentation were readily available there. Table 2 summarizes the major State efforts to develop water-use data bases.

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[a] The use of brand and commercial names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

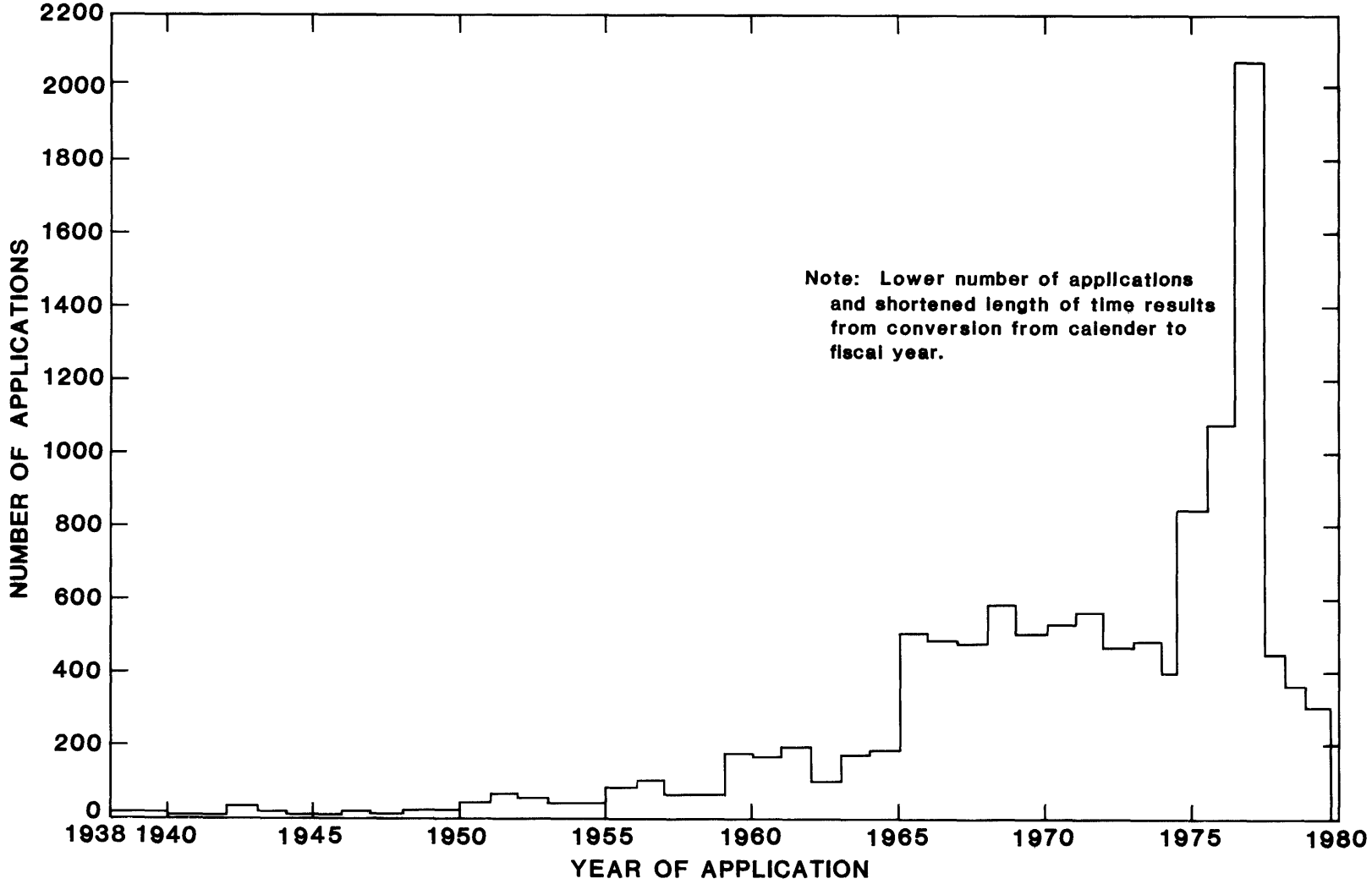

Figure 1.--Number of applications for Department of Natural Resources water-appropriation permits

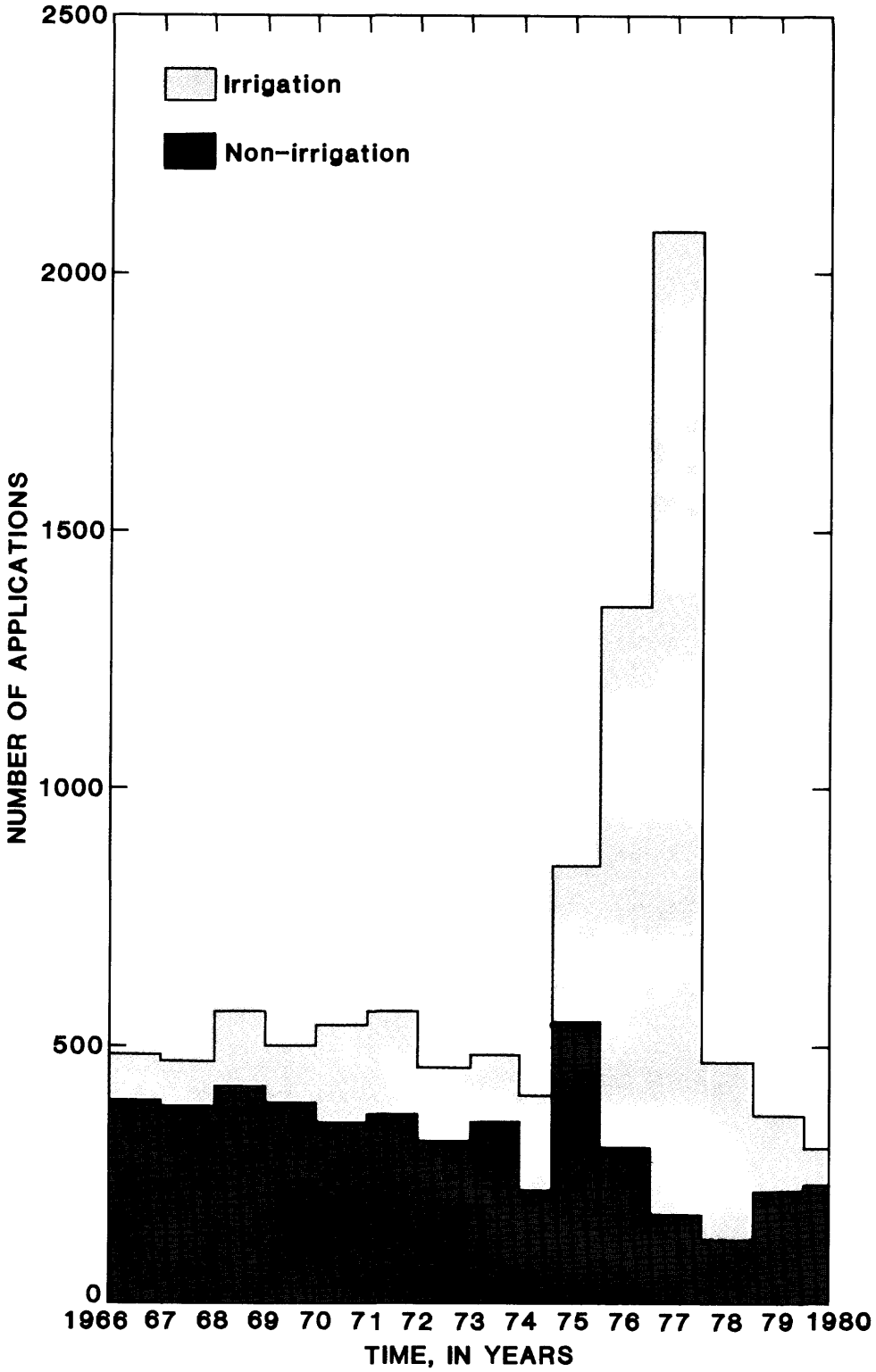

Figure 2.--Type of Department of Natural Resources water-appropriation permit applications, 1966-80

Table 2.--Chronology of water-use data base development

Date	Objectives	Agencies involved	Computer system	Data bases developed	Major problems
1965 & 1973	Computerize water-use permit data and annual water-use reports	MDNR	State Computer System	None	1. No in-house data-processing expertise 2. Inadequate funds
1976 to 1978	Develop an interagency statewide coordinated water-information system: water use for all users, permitted and unpermitted	LCMR funds MEA lead agency MDNR, MDH, MPCA, MGS, MSPA	UCC DBMS: S2000	1976 Water-use Data Base Irrigation Data Base	1. Too many data errors 2. No update procedures 3. Complicated to use
1978 to 1981	Develop data base to provide data to NWUDS on water withdrawals, usage, and returns	USGS funds MDNR lead agency data from MDH & MPCA	UCC DBMS: S2000	1978 Water-use Data Base	1. Data errors 2. No update procedures 3. Complicated to use 4. Too large to be efficient 5. No broad-based support from State agencies
1981 to 1984	Provide water-use data to meet the needs for water-resource management at the State level and the NWUDS requirements at the national level Develop links to major State water-related data bases	USGS funds USGS lead agency MDNR LMIC	MSPA's Prime DBMS: INFO	Minnesota Water-use Data System Ground-water Data Base	

LCMR - Legislative Commission on Minnesota Resources
LMIC - Land Management Information Center
MDH - Minnesota Department of Health
MDNR - Minnesota Department of Natural Resources
MEA - Minnesota Energy Agency
MGS - Minnesota Geological Survey
MPCA - Minnesota Pollution Control Agency
MSPA - Minnesota State Planning Agency
NWUDS - National Water-Use Data System
UCC - University of Minnesota Computer Center
USGS - U.S. Geological Survey
DBMS - Data Base Management System
S2000 - System 2000
INFO - Proprietary software for data management

The utility of the water-use and ground-water data bases was limited because of problems common with initial attempts at massive data computerization. The integrity of the data was not monitored closely by professional staff, resulting in errors that led to a loss of confidence in accuracy of the data. Update procedures were not developed, so the data base quickly lagged behind in changes to existing permits and no new permits were entered. The data-retrieval methods were too complex for non-computer personnel to master. While the data bases were valuable as a one-time compilation of data, they did not supply the needs of an ongoing water-resources-management program.

The problems experienced in Minnesota were by no means unique in the Nation. In the course of gathering data for the 5-year estimates of water use in the United States, the U.S. Geological Survey became aware of the problems in obtaining well-documented water-use data. As a result, the U.S. Geological Survey established the National Water-Use Information Program. The objectives of the program are to (1) collect, store, and disseminate water-use data to complement data on the availability and quality of the Nation's water resources, (2) develop and operate computerized systems that will be responsive to the data needs of users at both national and state levels, and (3) devise new methods and techniques to improve and standardize the collection and analysis of water-use information (Mann and others, 1982).

The National Water-Use Information Program is a cooperative effort between the U.S. Geological Survey and state agencies, in which funds are provided to assist in the development of state water-use data systems. Water-use data generated at the state level are aggregated by county and hydrologic unit (basin) and transmitted to the NWUDS (National Water-Use Data System) in Reston, Va. The cooperative effort between the MDNR and U.S. Geological Survey began in October 1978. The project gave the MDNR an opportunity to evaluate and expand the newly developed water-use data system. A systems unit was established by MDNR in January 1979 to centralize computer-data processing and to manage the project. Due to problems with staff turnover, the duties of the project chief were transferred from the MDNR to the U.S. Geological Survey in April 1981.

The National Water-Use Information Program encouraged collection of discharge or return-flow data, power generation, and other data related to water use in addition to data on water withdrawals. Acquiring these data required working with the agencies that already were collecting the data, such as the MPCA or MEA. The water-use project staff worked with the MDH by preparing maps and tables of data on public water-supply wells for use by the MDH sanitarians during their inspection. The corrected maps were returned to the water-use project staff for doing updates to the water-use data base. Coordination with the MPCA in collecting discharge data has identified new water users and improved techniques for estimating withdrawals and consumption by assuring that withdrawal and discharge estimates for the same facility are compatible. Collection of new data types also required revising the design of the water-use data base.

Design of a new water-use data base, containing data elements required for both NWUDS and the MDNR and eliminating some of the design problems encountered in the 1976 water-use data base, was completed in spring 1980. The new

structure resolved some of the problems of the first data base, but by the time 1978 and 1979 reported-pumpage data had been entered into the data base, the operating costs were extremely high. In addition, the problems of quality control, update and maintenance procedures, and difficulty of retrieval encountered in the past were not resolved. Only reported pumpage and basic permit data had been entered into the data base, while efforts to estimate unreported use and to enter discharge and new data from other agencies remained uncompleted. The change in project leadership to the U.S. Geological Survey in April 1981 led to a reevaluation of the water-use information program in Minnesota. As a result, both the 1978 water-use and the irrigation groundwater data bases were redesigned. These changes led to the current water-use data system.

MINNESOTA WATER-USE DATA SYSTEM

A major modification to Minnesota's water-use program was needed to resolve the problems described previously. The objectives of the program in Minnesota are to provide water-use data for water-resource management at the State level and to meet NWUDS requirements at the national level. The Minnesota Water-Use Data System is designed to store several different types of data. The main types of data stored for each individual water user are (1) location, (2) reference numbers that link data on individual water users to data contained in other water-related data bases, (3) water resources affected by individual withdrawals and discharges, (4) quantity of annual withdrawals and discharges by individual users in million gallons, (5) permit information and constraints put on the user, and (6) descriptors to facilitate trend analysis. The Minnesota Water-Use Data System uses the INFO data-base management system and is easier to use and much more cost effective than previous versions. The system allows easy access to data on individual permits, areal and source summary statistics, and other data bases containing related data. Updating procedures are simple, quick, and inexpensive. Because reported water use alone does not provide information on the total stress on the hydrologic system, estimates of unreported water use supplement reported water use. The water-use data system flags facilities that did not report pumpage for a particular year and allows systematic estimates to be made of facility-water use. The system was developed and is maintained through the cooperative efforts of the Minnesota Department of Natural Resources, Minnesota State Planning Agency, and the U.S. Geological Survey.

Structure of the Data Base

The water-use data system stores data elements considered to be important in meeting State water-resource management objectives. These data elements can be grouped into major data types that have a function in the management scheme. The function groups, known as links, management, and trend analysis, are illustrated in figure 3. A complete description of each data element can be found in Appendix A. The following is a brief discussion of each function group.

The MDNR PA number (Permit Application number) is the primary reference for water users in the State. There may be more than one installation, that is, well or surface-water intake, under one permit. In order to establish a

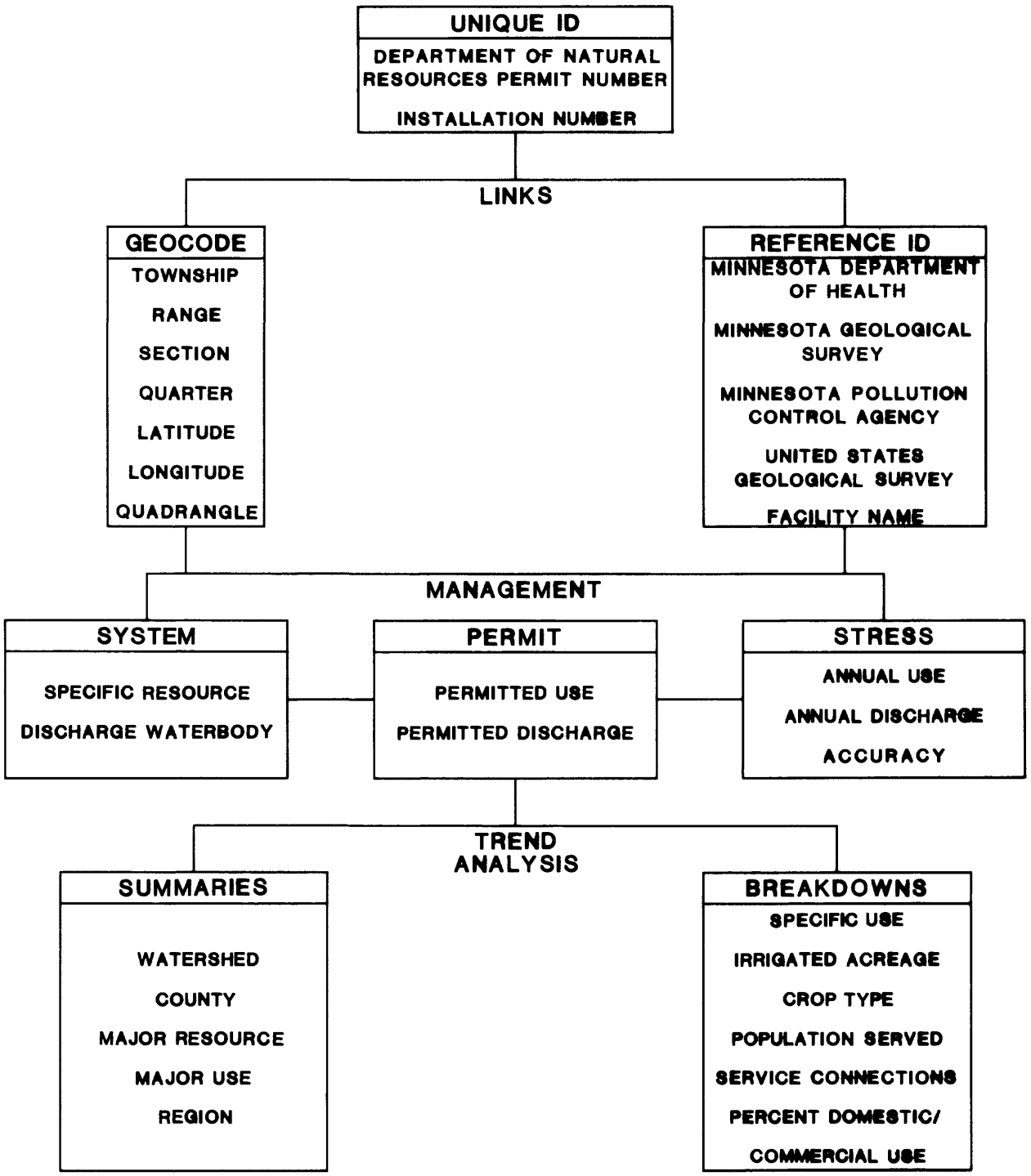

Figure 3.--Structure of the Minnesota Water-Use Data System

unique identification for each installation, the PA number is used in conjunction with the installation number.

Links with data stored in other data bases form the next level of major function groups. The geocode, or location group, includes data elements that describe the location of the water user three ways (1) public land-survey coordinates (township, range, section, quarter, and government lot), (2) latitude and longitude, and (3) U.S. Geological Survey topographic quadrangle map. The location confidence is included to indicate the reliability of the location data. The second group consists of reference numbers that help identify the same water user in different data bases. These include the Minnesota Geological Survey unique well number, facility name, Minnesota Department of Health municipal number, NPDES (National Pollutant Discharge Elimination System) number assigned by the Minnesota Pollution Control Agency, and the U.S. Geological Survey site-identification number.

The management section is composed of data elements that describe the hydrologic system, the water-use permits, and the applied stress. The system group contains data elements related to the water resource affected by the water user. The amount of withdrawals from a specific lake, stream, ditch, or aquifer is stored in the specific-resource element. The amount of water discharged to specific lakes or streams is stored in the discharge-water-body element. The water-use permit group includes permitted annual withdrawal, pumping rate, and irrigated acreage. Also included are requirements for water-level measurements, other active or inactive PA numbers, whether a complaint has been filed, whether wells are manifolded, status of well, and the number of installations under that permit. The stress group stores data on quantity of water withdrawn or returned to the hydrologic system. For each year, stored withdrawal data include annual and monthly withdrawals in million gallons, and the measured accuracy or source of the reported or estimated values for each installation. Discharge values are for annual and average daily discharges, in million gallons. The measurement accuracy element enables a distinction to be made between reported values of 0.0 and the 0.0 value automatically supplied by INFO when no value is reported.

The third section includes data elements that enable analyses of water-use trends. Summary elements will be used in aggregations and includes MDNR region (groups of counties as enumerated in Appendix A), watershed (hydrologic unit), major resource (lake, stream, or ground water), and major use (municipal, commercial, industrial, water-level maintenance, non-crop irrigation, and major-crop irrigation). Data elements that can be used to identify separate factors affecting use include specific use, SIC (Standard Industrial Classification) code, number of irrigated acres, crop type, population served, number of service connections, and percent of domestic use versus industrial use supplied by municipalities.

Much of the data stored in the water-use data system was in several other computer files at the University of Minnesota Computer Center. The computerized files were reformated to be compatible with the other State water-related data bases. The new file structure is illustrated in figure 4. Instead of independent water-use and ground-water data bases, there are six separate files, one file common to both data bases, one specifically for the

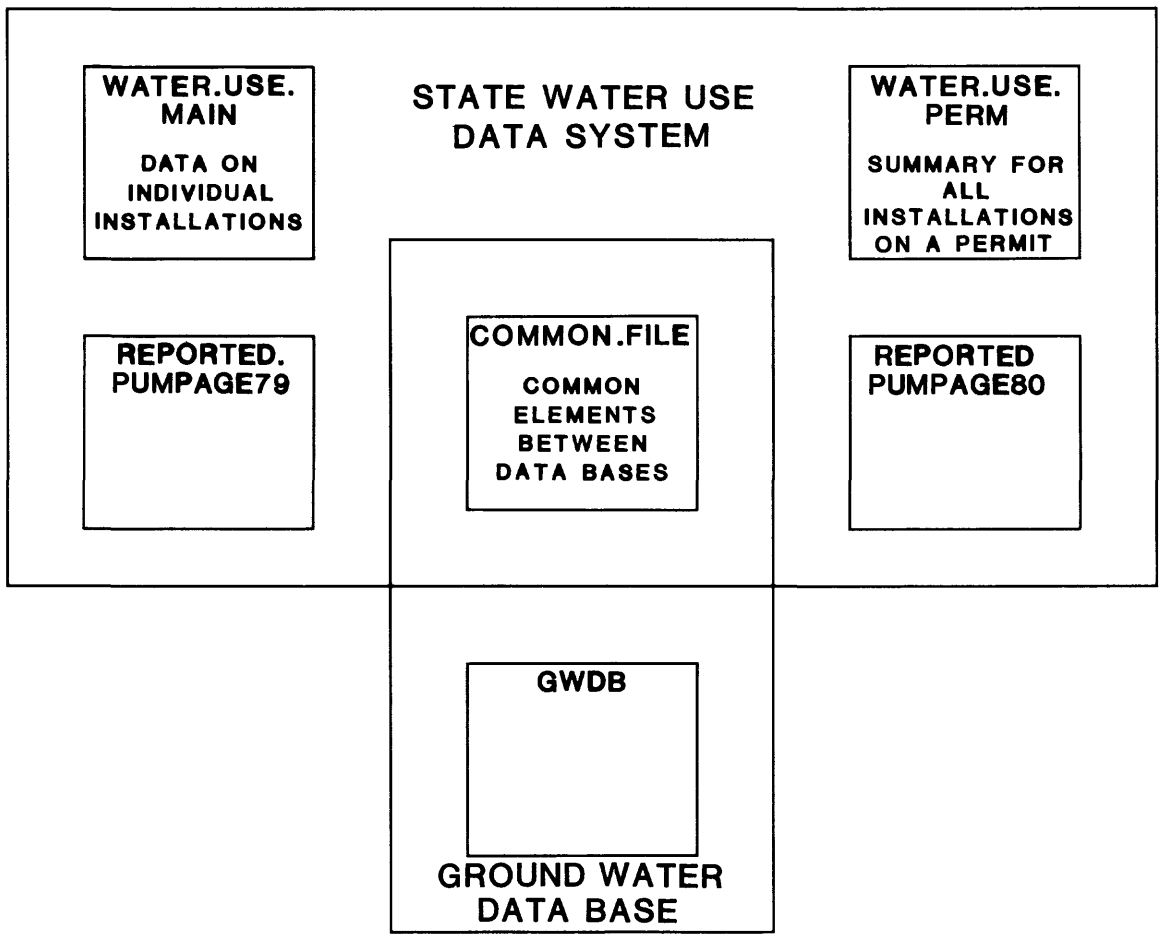

Figure 4.--Individual files that compose the Minnesota Water-Use Data System and Ground-Water Data Base

ground-water data base, and four files for the water-use data base. The new structure avoided duplication of data elements by creation of the common file, requiring only one update to the system to correct both data bases. In the appendices, both the water-use and the ground-water data bases are described and the file location is given for the individual data elements. The formerly independent water-use data base is now referred to as the water-use data system.

Water-use data for each year are stored in a separate file. The method used to calculate or measure water use is coded for each year by user in the measurement-accuracy element (see Appendix A). If no report is received for a particular year, then an estimate of water use is entered with a corresponding entry of "estimate" into the measurement-accuracy element. Thus, it is possible to retrieve only reported data, only estimated data, or to retrieve total water use for any given category. Individual estimates of water use can be automatically transferred from the previous year's estimated or reported values, or can be derived by new calculations, as required.

Computer Software

During the summer of 1982, it became apparent that an additional cooperator in the Minnesota Water-Use Information Program was needed to improve the computer functions in the program. The LMIC (Land Management Information Center), which is part of the Minnesota State Planning Agency, was added as a participant because many of the State's water-related data bases were stored on the PRIME computer at LMIC. In addition, the relational data-base system, INFO, facilitated linking independent data files having a common component. LMIC has excellent data-processing capabilities and could assist in resolving many of the problems described previously. During FY 1983, LMIC assisted the program by (1) reformating computerized data, (2) improving methods of data entry, update, and verification, (3) developing menu-driven programs to retrieve data on individual users or summaries, and (4) presenting workshops and individual assistance in using the new computer system to MDNR staff. The result is a computer system that is easy to use.

LMIC developed an interactive menu-driven form system for data entry, update, and verification. The system was developed to speed data entry by combining elements of previously automated data files and displaying the data on the terminal screen. Data-entry personnel could review the data and only needed to update what was missing or incomplete. A schematic diagram of this system in shown in figure 5. While it took several months to develop this system, it made use of most of the data-automating efforts the MDNR had made over the past several years and, once active, data entry proceeded at a much faster rate. The menu-driven form system also can accommodate simple routine updates in an efficient manner.

An interactive menu-driven system was developed for retrieving reports on individual users and summaries of groups of users. The final format of these reports probably will differ from the current format and will be included in a later, more rigorous documentation of the system to be prepared by the LMIC. Retrieval of information on individual reports appears on the screen in the same form used for data entry. Retrieval of summary information can be done by

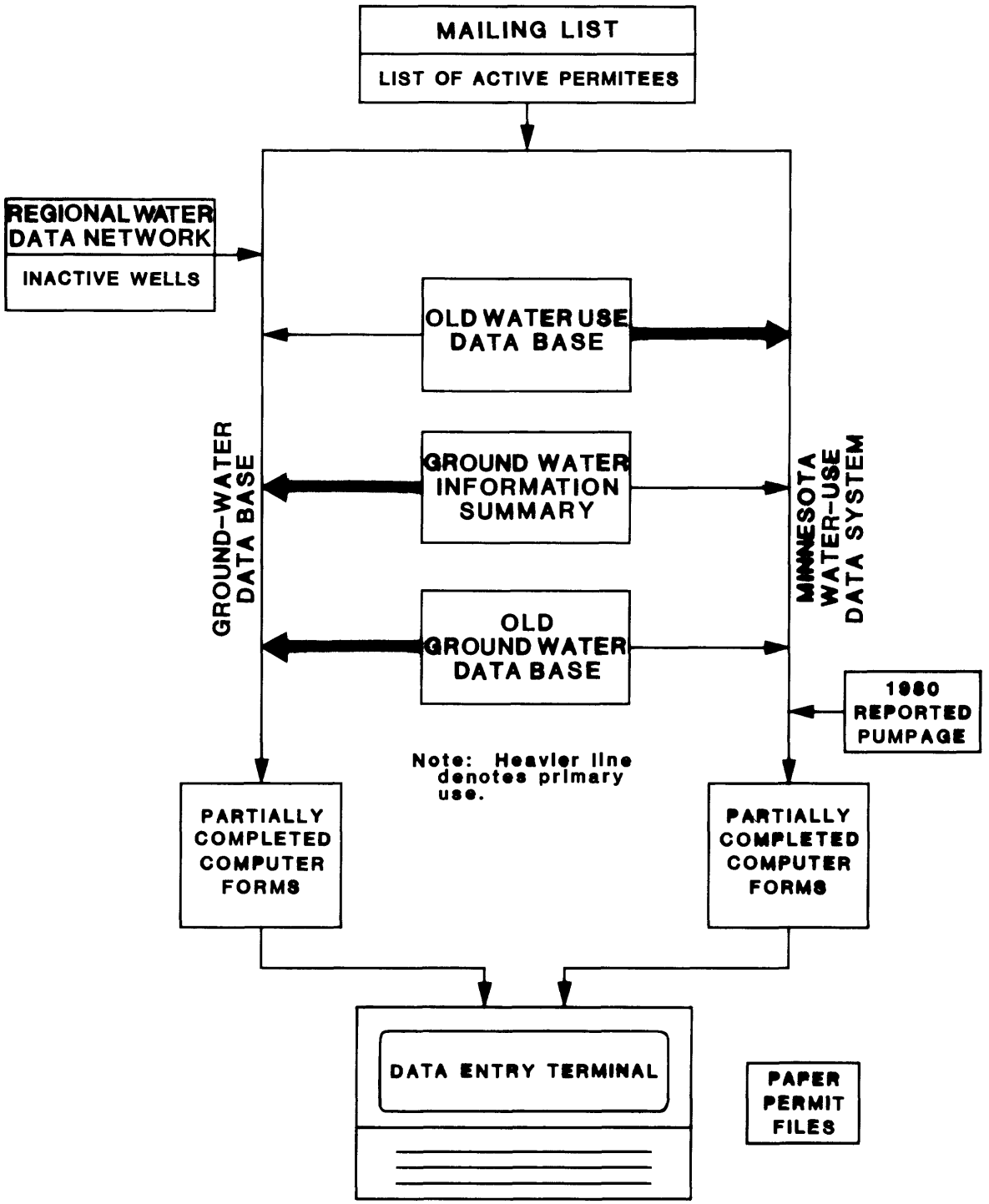

Figure 5.--Methods used to partly automate data entry into the Minnesota Water-Use Data System and Ground-Water Data Base

watershed, resource, county, and use type. In addition to the menu-driven reports, reports also can be prepared to meet specific objectives. LMIC also can generate computer-plotted maps of the data at any of several scales.

A major part of the National Water-Use Information Program is aggregation of water use by county and hydrologic unit (watershed). LMIC and the U.S. Geological Survey are developing methods to efficiently aggregate and transmit data to NWUDS.

Stored Data: Reported and Estimated Water-Use Data

Water appropriators are required to report monthly water use on an annual basis to the MDNR. Pumpage-report forms for every installation are sent in December to every permit holder by the MDNR. The pumpage reports and processing fees are to be returned to MDNR by February 15 of each year. Generally, between 80 and 90 percent of the permit holders file pumpage reports. These reports are computerized and entered into the Minnesota Water-Use Data System. However, reports may be missing from 10 to 20 percent of permit holders and, of course, from water users who have no water-appropriation permits. Annual water-use reports are estimated to include only 60 percent of the water used in the Twin Cities area (Horn, 1983), and the completeness of use estimates varies considerably in each county. Therefore, estimates of unreported water use are made to supplement reported water use and estimate total stress on the hydrologic system. Methods for estimating unreported water use were developed for each of the major use types, municipal, self-supplied industrial, irrigation, rural domestic, and livestock. The methods were used in deriving the 1980 NWUDS water-use data for Minnesota and are briefly outlined below. The methods for estimating water use will continue to be refined as further information and experience allow.

Municipal Use

Municipal use or public supply refers to water withdrawn by public and private water suppliers and delivered to a variety of users for domestic or household use, public use, industrial use, and commercial use (Solley and others, 1983).

Estimates of municipal water use were made using a list from the Minnesota Department of Health of (1) all municipalities in the State that have their own water supply, (2) the population served, and (3) the percent of municipal water supplied to commerce and industry. Initial estimates were made using the following formula:

$$\text{Municipal use (million gallons)} = \frac{\text{population served} \times 100 \text{ gal/capita/day}}{10^6 \text{gal/Mgal} \; (1.0 - \% \text{ industrial \& commercial})}$$

For instance, the water use for a municipality serving 50,000 people, of which 18 percent was supplied to commerce and industry would be (100 gal/day x 50,000)/(10^6gal/Mgal (1.00 - .18)) = 6.1 Mgal/d. A value of 100 gallons per capita was used to represent not only consumption per person, but also line loss, fire fighting, city sanitation and city recreational use. This value compared favorably with municipalities where total use and industrial and

commercial use were known. An estimate of 15 percent (Minnesota Department of Health, written commun., 1981) was used when the percent of water supplied to commerce or industry was not provided. The municipal water-use estimates were checked against any previously reported use for the same municipality. If the previously reported value was within 10 percent of the calculated value, the previously reported value was used. This method provides both a complete list of potential users and a systematic method for estimating use.

Self-Supplied Industrial Use

Self-supplied industrial water use refers to water withdrawn by industries, including, but not limited to, steel, chemical and allied products, paper and allied products, mining, petroleum refining, and thermoelectric power generation (Solley and others, 1983).

Estimating self-supplied industrial use was initiated by comparing a list of users with MDNR water appropriation permits with a list of users having NPDES permits. This resulted in a list of major industrial water users (greater than 5 million gallons per year) that probably are independent of municipal systems for supply or sewage. In the Twin Cities area, a list of self-supplied industries and their estimated usage had been compiled for several U.S. Geological Survey projects. Estimates of water use were made from reported water use for the previous year if available. If not available, then the estimates were used that already had been calculated for the Twin Cities area (Horn, 1983). If it wasn't possible to use these two alternatives, then a minumum use was estimated from the NPDES discharge value. Most of the estimates of water use for self-supplied industries could be made by these methods. For any other user, a value of five million gallons per year was used until more information becomes available on the individual user. As this method concentrates on identifying the largest users with their own water-supply system, it probably accounts for a significant part of the self-supplied industrial use.

Irrigation Use

Methods of estimating water use for irrigation are based on information on irrigation-permit holders. A ratio of permitted to reported irrigated acreage was calculated for each county. This ratio was then applied to the permitted irrigated acreage for irrigators who did not report their water use. The amount of water applied per acre by the irrigators who reported their use is applied to this estimated value of irrigated acreage, resulting in a county-wide estimate of irrigated acreage and water used. An example for Clay County in 1980 is given below:

Reported irrigated acreage

Total irrigated acres included in water-appropriation permits.. 10,773 acres

Permitted acreage of users who reported (87 percent of total acreage)..... 9,345 acres

Actual reported irrigated acreage (61 percent of the reported acreage)	5,703 acres
Estimated irrigated acreage	
Permitted acreage of users who did not report	1,428 acres
Estimated additional irrigated acreage (1,428 x 0.61)	871
Total estimated acreage (5,703 + 871)	6,574 acres
Irrigated water use	
Reported irrigated water use	1,055.5 Mgal
Average amount applied per acre (1,055.5 Mgal/5,703 acre)	.185 Mgal
Estimated total water use for irrigation in Clay County for 1980 (0.185 Mgal/acre x 6,574 acre)	1,216.7 Mgal

This value is calculated annually for each county. The ratio of permited acreage to reported use also is applied to individual irrigators so that estimates can be made for irrigation use in each watershed (hydrologic unit). As the permits are updated, and inactive permits removed from the data base, this ratio should become more accurate. However, these estimates do not take into account irrigators without permits who, according to preliminary field reconnaissance, may represent about 10 percent of the total number of irrigators (Minnesota Department of Natural Resources, oral commun., 1984).

Rural-Domestic and Livestock Use

Rural-domestic and livestock uses were estimated on a county-wide basis. Rural-domestic water use was calculated by multiplying the non-publicly supplied population by a constant. The non-publicly supplied population was determined by subtracting the population supplied by municipalites obtained from the Minnesota Department of Health list of public-water suppliers from the total population of the county according to the 1980 census. The 1980 non-publicly supplied population was multiplied by 88 gal/capita. Less water per capita was assumed here than in municipalities because of (1) fewer water-using appliances, (2) low system loss through leaks, (3) no municipal use equivalent to parks or fire fighting, and (4) use that may be restricted by limited supplies from barely adequate wells. It was assumed that all water in this category was supplied by ground water.

Use of water by livestock was derived from a report by the Minnesota Crop and Livestock Reporting Service (1980). It was estimated that 15 percent of the water used by livestock was surface water and 85 percent was ground water (W.B. Mann, IV, U.S. Geological Survey, written commun., 1971). The following estimates were used (Levy and others, 1977):

milk cow	(20.00 gallons per day)
other cattle	(10.00 gallons per day)
hog	(3.00 gallons per day)
sheep	(2.00 gallons per day)
chicken	(0.04 gallons per day)

WATER-RESOURCE INFORMATION SYSTEM

The MDNR and U.S. Geological Survey developed the MWUDS (Minnesota Water-Use Data System) using INFO as an integral part of the Water-Resources Information System. INFO is a relational data-base management system making it easy to relate or link MWUDS to other data bases stored in the PRIME computer at LMIC (see table 3).

An inventory was made of statewide water-related data bases, and links were developed with MWUDS. There are two main types of state data bases; those supplying information on the hydrologic system and those supplying information on the stress applied to the hydrologic system. MWUDS was designed to link these two types of data bases in order to provide data for management of Minnesota's water resources (fig. 6). Major water-related data bases that define the hydrologic system include (1) lake summary file (LAKES), (2) river kilometer index (RKI), (3) watershed index, (4) ground water (GWDB), (5) ground-water level (OBWELL), (6) water well, and (7) ground-water information summary (GWIS). Major data bases that define the stress applied to the system include (1) regional water-data network system (RWDNS), (2) water-use mailing list, (3) electric facilities, (4) non-automated data file on municipal water-supply, and (5) non-automated files of discharge (NPDES) data. Each of these data bases is described briefly in table 3 and in the following paragraphs. The MDNR permit and installation number, and the Minnesota Unique Well Number are common identifiers relating data bases. Each data element is password protected so that the agency responsible for the data base can decide which elements they wish to share with other agencies or users, and to prevent any unauthorized changes to the data base. Many of the data bases are linked through geocodes, a geographic-location system based on public land-survey coordinates for township, range, section, and quarter section.

Hydrologic-System Data Bases

The lake summary file (LAKES), developed by the interagency SWIM (Systems for Water Information Management) committee and the MDNR, summarizes geographic, physical, chemical, shoreland development, and fisheries information about lakes throughout the State. Each lake is referenced by a unique lake number, which also is used as the Resource Number data element in MWUDS to identify lakes. LAKES is stored on LMIC's PRIME computer.

The location of Minnesota's watercourses (rivers, streams, and ditches) has been digitized as part of the RKI (River Kilometer Index) and stored on

Table 3.--Major State water-related data bases

Water-related data bases Type of data	Abbrev-iation	Function	Developer	Storage	Link(s) to Minnesota Water-Use Data System	Type of data
Minnesota Water-Use Data System	MWUDS	Manager	USGS/MDNR	LMIC-Prime	---	location, resources affected, amount of withdrawal and return, agency index numbers
Lake Summary File	LAKES		MDNR/SWIM	LMIC-Prime	Lake number, geocode	major characteristics of lakes
River Kilometer Index	RKI		MDNR/LCMR	LMIC-Prime	River number, geocode	river tributary-hierarchy relationships, distance upstream from mouth
Watershed Index			MDNR/LCMR	LMIC-Prime	Watershed number, geocode	index to major and minor watersheds mappable at any scale
Ground Water	GWDB		MDNR/USGS	LMIC-Prime	DNR permit number, MN unique number, geocode	high-capacity wells, aquifer, confining bed, well construction, driller's pump-test data
Ground-Water Levels	OBWELL		MDNR	LMIC-Prime	MN unique number, geocode	measured water levels for specific wells by aquifer
Ground-Water Information Summary	GWIS		USGS/SWIM	LMIC-Prime	MN unique number, DNR permit number, geocode	location, general description, aquifer, agency identification number
Water Well			MGS	to be LMIC-Prime	MN unique number, geocode	location, lithologic log, aquifer, well construction

Table 3.--Major State water-related data bases--Continued

Water-related data bases	Abbrev-iation	Function	Developer	Storage	Link(s) to Minnesota Water-Use Data System	Type of Data
Minnesota Water-Use Data System	MWUDS	Manager	USGS/MDNR	LMIC-Prime	---	location, resources affected, amount of withdrawal and return, agency agency index numbers
Regional Water-Data Network System	RWDN		MDNR/LCMR	LMIC-Prime	DNR permit number, geocode	permit data on water users and changes to surface-water bodies
Water-Use Mailing List			MDNR	LMIC-Prime	DNR permit number	names and addresses of permitted active water users
Electric Facilities			MED	Univ. of Minn.	Facility name	power-generating facilities, annual power generation
Municipal Water-Supply Files			MDH	Manual Files at MDH	Municipal number	municipal population, service connections, usage, quality
NPDES Discharge Files	NPDES		MPCA	Manual Files at MPCA	NPDES number	discharge

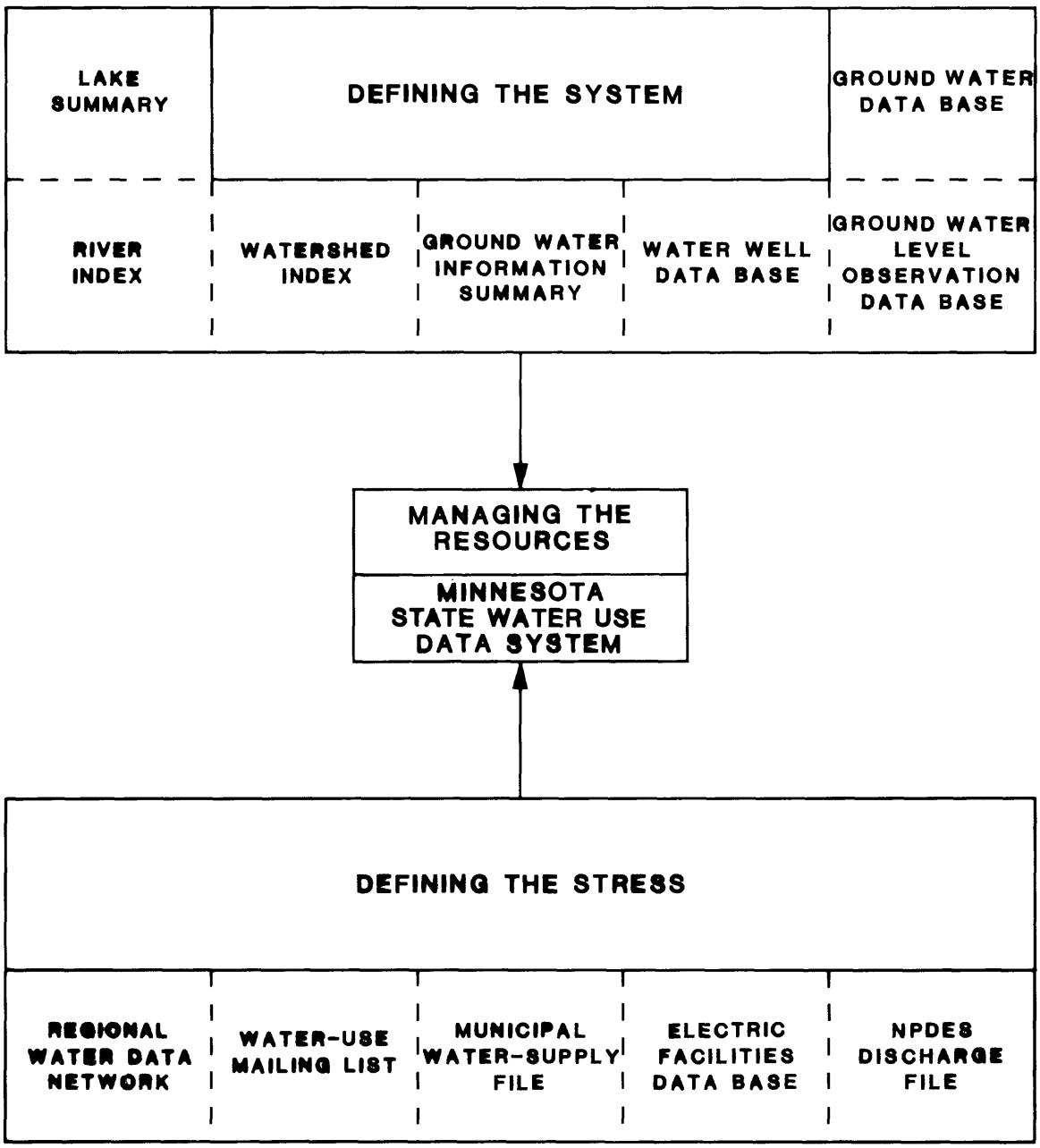

Figure 6.--Major State water-related data bases

LMIC's PRIME computer. Each watercourse is assigned a stream number based on its relationship as a tributary to a main stream. For instance, the Mississippi River stream number is 1; the Crow Wing, the 96th tributary is 1-96; and the Leaf River, the 20th tributary to Crow Wing, is 1-96-20. The watercourses also are indexed by kilometer in an upstream direction from the mouth of a watercourse, or from the point where a stream crosses the state boundary for the last time. In MWUDS, water withdrawals from streams have the stream number in the Resources Number data element. Discharges to streams have the stream number in the Discharge Waterbody data element. At present, data cannot be retrieved by RKI from MWUDS.

The watershed index identifies over 5,600 watersheds or drainage basins in the State with an area of at least 5 mi^2 as defined by a continuous topographic height-of-land drainage divide. These watersheds are aggregated into 81 major watersheds corresponding to the Water Resources Council Hydrologic Cataloging Units. A geocode is assigned to each 40-acre parcel of land within a watershed and stored in a computer file on LMIC's PRIME computer. Currently, the U.S. Geological Survey and the U.S. Army Corps of Engineers are refining the minor watershed delineations and digitizing the watershed boundaries within the Minnesota River basin. Each minor watershed is assigned a five-digit reference number, the first two digits representing the major watershed number, and the last three digits represent a sequence number within the watershed. A major watershed code is assigned to every installation and permit record in MWUDS. Withdrawals from pits, ponds, or sloughs are referenced to the minor watershed number in the Resource Number data element. Discharges to drain fields, cesspools, holding ponds, or onto the ground are identified within each minor watershed in the Discharge Waterbody data element.

Withdrawals from specific surface-water bodies have been adequately identified in the MDNR permit system for many years. However, ground-water withdrawals, which account for approximately half of all water use in Minnesota, excluding withdrawals for thermoelectric power, cooling, or hydroelectric-power generation, are not differentiated by aquifer. Because aquifers, like rivers or lakes, contain a finite volume of water, declining water levels occur in aquifers as well as lakes or rivers and need to be monitored and managed individually. The irrigation ground-water data base does not adequately meet this need because it stores only data on irrigation wells that were permitted before 1978. The structure of the GWDB (ground-water data base) was revised in 1981 to allow storage of aquifer data, reduce storage and retrieval costs, and improve efficiency. The current structure is illustrated in figure 7. As of 1983, detailed information for 60 percent of all permitted high-capacity wells (capable of pumping more than 70 gal/min) are stored in the data base. The types of data stored in the ground-water data base are given in Appendix B.

The OBWELL (ground-water level data base) of the MDNR contains water-level measurements in selected wells. These data are linked to MWUDS by the Minnesota Unique Well Number, a unique six-digit number assigned by the Minnesota Geological Survey to each well that has a well log. These numbers are assigned to all wells drilled since 1975 by prenumbering the Minnesota Department of Health forms that are completed by the driller when the well is drilled. Wells drilled prior to 1975 that have logs are assigned a unique

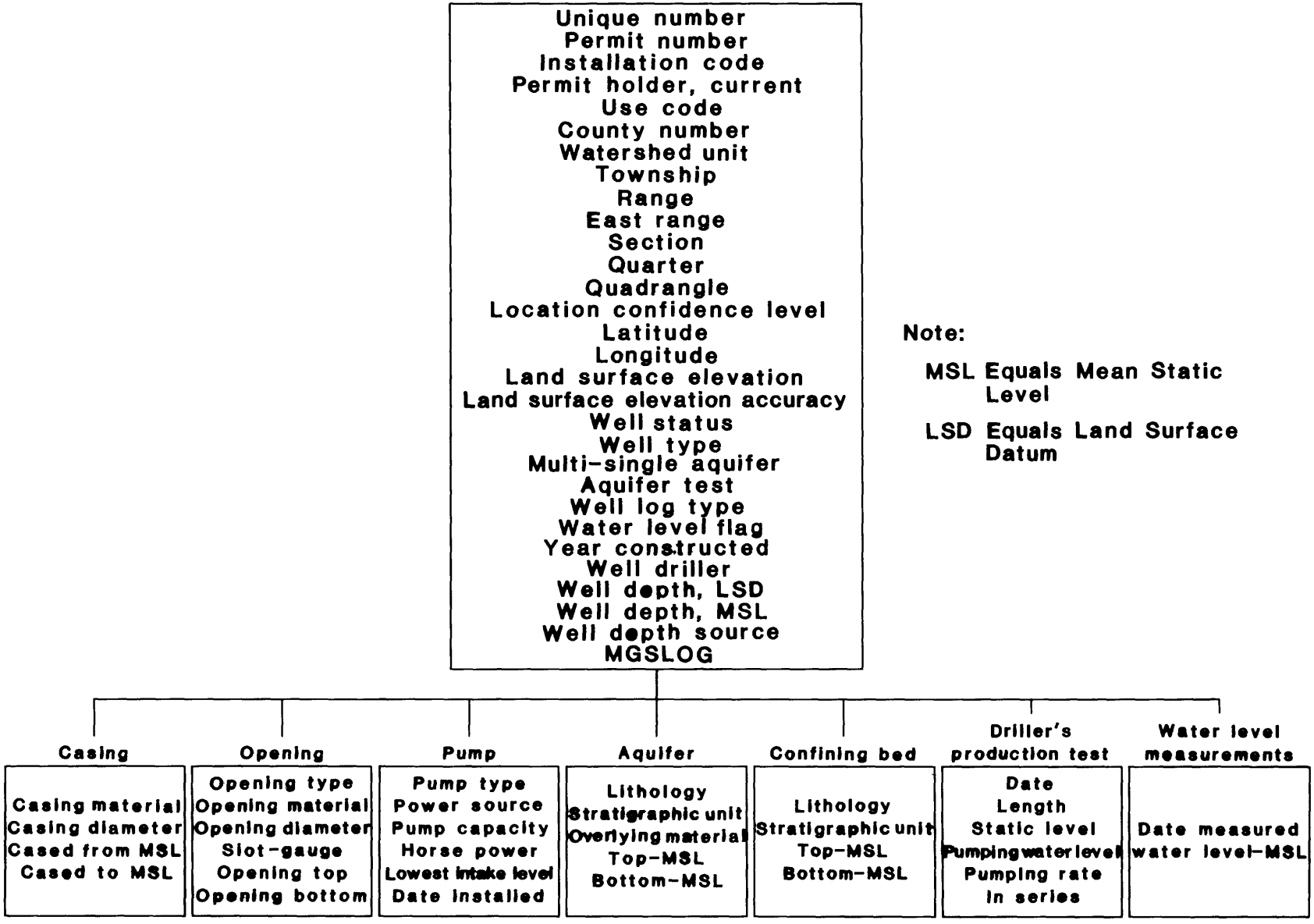

Figure 7.--Structure of the Ground-Water Data Base

number by the Minnesota Geological Survey. The data base is stored on LMIC's PRIME computer.

The GWIS (Ground Water Information Summary) was developed through the cooperation of the SWIM committee, LMIC, and the U.S. Geological Survey. Information on the location, description, aquifer, and agency reference numbers for selected wells throughout the State is stored in GWIS. It also will contain an index to detailed information on water use, quality, lithology, and water levels that is contained in other State and Federal data bases. MWUDS is linked to GWIS both through the MDNR permit and installation number and the Minnesota Unique Well Number described above.

The Minnesota Geological Survey developed a water-well data base to contain information on individual wells having a well log. Locations of wells that are in this data base have been field checked, and the stratigraphy recorded on the well logs has been reviewed by a geologist. Descriptions of the lithologic log, location, aquifer, and construction history for each well are included in the data base. Although this data base is stored at the University of Minnesota Computer Center, plans are being discussed to transfer it to LMIC's PRIME computer.

Hydrologic-Stress Data Bases

Information on the stress applied to the hydrologic system is available mainly through MDNR permit. Information on MDNR permits for water appropriation and modification to surface-water bodies was tabulated originally in the master permit index. In 1981, the Legislative Commission on Minnesota Resources provided funding to MDNR to develop improved methods for coding, storing, and reporting data related to water permits. The new system, the RWDNS (Regional Water Data Network System), contains more permit information, improves access to the data, and allows tracking of permit data (Minnesota Department of Natural Resources, 1983). The water-use project staff worked closely with the RWDNS staff to avoid duplication of effort and to allow sharing of data and automatic updating of the MWUDS when the RWDNS was updated. For these reasons, both the MWUDS and RWDNS are stored on LMIC's PRIME computer in an INFO data base, and are linked through common MDNR permit and installation numbers.

The mailing list data base is used to generate requests for the annual water-use reports from users with water-appropriation permits. Previously, the list had been maintained separately from the water-use data base and extensive updates were required prior to the annual mailing. This data base also was transferred to LMIC's PRIME computer so that it could be updated with MWUDS and linked to it by MDNR permit number.

The Minnesota Energy Agency maintains the Electric Facilities data base that contains data on power-generating facilities. Data on power generation, required by NWUDS, are found in this data base. Data in MWUDS can be linked by facility name to this data base.

The Minnesota Department of Health maintains files on every municipal water facility in the state. These manual data files contain the most recent data on population served and number of service connections. Data on water

use, quality, and well construction are found also in these files. Name and municipal identification number link these files to MWUDS.

The Minnesota Pollution Control Agency maintains manual files of monthly and annual discharge through the NPDES permit system. There are plans to automate these data. The link to MWUDS is through the NPDES permit number.

METHODS TO IMPROVE ACCURACY OF REPORTED AND ESTIMATED WATER-USE DATA

Although many water users in Minnesota report annual water use to the MDNR, significant errors in reported water use occur. These errors may be due to incorrectly completing the water-use report form, a poorly functioning meter, or no meter at all. When there is no meter on the water supply, estimates of water use are reported that are developed by the user from pumping rate and number of hours of operation. These water-use reports, whether based on meter readings or estimates, may be incomplete or inaccurate. When annual water-use reports are unavailable, water use for municipalities, industries, and irrigation is estimated by methods described previously in this report. The accuracy of both reported and estimated water-use data can be improved by methods discussed in the following paragraphs.

Municipal

Municipal water-use usually is metered, which results in water-use reports that are reasonably accurate. However, comparisons with estimates of use should be made to help catch errors that may occur. Computer programming can be done to match the current water-use reports against previous reports or estimates. Any new report differing by more than 10 percent can be flagged for investigation. Preliminary analysis indicates that the estimating methods described earlier are fairly reliable. In addition, the Department of Natural Resources is making an effort to bring all municipalities under permit, so the need for refining these estimates is not critical for municipal use.

Each municipality is visited by sanitarians from the Department of Health every 15 months to note changes in the system. Visits with local water superintendents had been used to verify information previously collected by the Department of Natural Resources and the U.S. Geological Survey, including the location and description of municipal wells. These data are being used to correct data entered into MWUDS. Improved data on population served and on the number and type of service connections may be collected in the future by State sanitarians.

Self-Supplied Industry

Reliable water-use information is much more difficult to obtain for self-supplied industrial or commercial facilities. This type of use is not as visible as irrigation nor as well documented as municipal use. Improved estimates of industrial use depend on a complete inventory of all users and improved methods for estimating use. The current list of users includes those with active NPDES discharge permits and MDNR water-appropriation permits both active and inactive. Municipal water superintendents were asked to supply the names of owners of large private wells in their area during the municipal

inventory described previously. This list of well owners, along with information from the Directory of Manufacturers for Minnesota, lists from Chambers of Commerce, and occasional canvassing of particular areas can be used to develop a more complete list of users. As necessary, owners of private-industrial wells can be contacted for information.

Although some industrial wells have meters, many do not. Field investigations to measure pumping rates and check timing methods are necessary to improve the quality of reported use. Pumpage from only a small percentage of wells that have meters needs to be measured for verification. Unmetered facilities can be divided into groups based on annual use, and the number of wells selected for measurement can be determined based on the magnitude of use and the desired accuracy of water-use estimates. For instance, all facilities withdrawing more than 100 million gallons per year might have pumping rates measured, and 50 percent of facilities withdrawing more than 25 million gallons per year might have pumping rates measured. While the measurements are being done, the techniques used for recording number of hours of operation can be discussed with the plant superintendent.

Irrigation

Water use for irrigation increased dramatically from 1970 to 1980; from an estimated 20 Mgal/d in 1970 (Murray and Reeves, 1972), to an estimated 47 Mgal/d in 1975 (Murray and Reeves, 1977), to an estimated 160 Mgal/d in 1980 (Solley and others, 1983). Many of the areal studies done by the U.S. Geological Survey assess the availability of water for irrigation throughout the State. The MDNR has focused effort on irrigation water use since the mid-1970's drought, and has between 85 and 90 percent (Minnesota Department of Natural Resources, oral commun., 1984) of irrigators under permit. However, little work has been done to determine the accuracy of the reported water use.

Because there are approximately 4,000 irrigators under permit, any program to check the accuracy of reported irrigation pumpage will have to be well planned, coordinated, and executed. Groups in the State that have expressed some interest in such a program include irrigation associations, University of Minnesota Extension Service, U.S. Soil Conservation Service, Soil and Water Conservation Districts, and Resource Conservation and Development Commissions as well as the MDNR and the U.S. Geological Survey. By using statistical sampling methods, the accuracy of reported pumpage can be evaluated by measuring a representative number of randomly selected wells. At each selected well, the following would be done (1) measure the pumping rate with a non-invasive transient-time flowmeter, (2) record the total hours of pumping during the irrigation season using a timer on the irrigation equipment, pump or power sources, or by developing a kilowatt-hour conversion factor if necessary, (3) measure static water levels throughout the year, and (4) measure the drawdown while the well is pumping. These measurements, combined with well-construction information, allow calculation of actual water pumped, the distance between the pump intake and the pumping water level, and the electricity or fuel consumption per gallon of water. This information can help irrigators make their operations more efficient.

After irrigation use has been documented by statistical sampling, a program for monitoring the accuracy of reported pumpage can be implemented. The amount of water used for irrigation depends not only on annually changing values for crop type, acreage, and precipitation, but also on relatively stable environmental characteristics in each region such as soil type. Regional constants based on these environmental characteristics can be developed from verified irrigation practices and water use. A computer program can be developed to combine the regional constant, seasonal precipitation, crop type, and acreage reported by the permit holder to calculate an approximate value for the amount of water used by the permit holder that year. Further programming will allow the calculated value to be compared with the reported value so that any significant discrepancies can be resolved.

Estimates of irrigation water use also can be improved by a complete inventory of irrigation wells, irrigated acreage, and system types, with the information plotted on topographic maps. The inventory could be assisted by interested groups or individuals from local Soil and Water Conservation Districts, Irrigators Association of Minnesota, and University of Minnesota Extension Service. Data from the inventory would be compared with data already in MWUDS to determine the (1) number of wells that do not have permits, (2) accuracy of well locations, and (3) completeness of the information for each well. Additional methods, such as analysis of low-altitude aerial photographs obtained from State and local agencies, can be used to identify irrigated plots. This effort can be followed by interviews with well owners. Until all irrigators come under permit, water use will be estimated in accordance with methods described previously.

SUMMARY

Minnesota legislators began as early as 1937 to provide for regulation of the use of ground water and surface water in the State. Several times prior to 1981, the State tried to computerize water-use information. Each time, computerization was beset by problems of insufficient monitoring of data before entry, no update or maintenance to keep the data current, and too little in-house data-processing expertise to develop, maintain, or retrieve the water-use data.

The U.S. Geological Survey developed the National Water-Use Information Program to assist states in developing documented water-use-information systems for local, State and Federal agencies. The U.S. Geological Survey combined the experience from many states with that of the Minnesota Department of Natural Resources and, later, the Land Management Information Center to develop the Minnesota Water-Use Data System as part of a Minnesota Water-Resources Information System.

The MWUDS was designed to meet the objectives of both the State of Minnesota and the National Water-Use Information Program. Data contained in MWUDS can be categorized in the following manner (1) location, (2) reference numbers that link data on individual water-users to data contained in other water-related data bases, (3) water resources affected by individual withdrawals and discharges, (4) quantity of annual withdrawals and discharges by individual users, (5) permit information and constraints on the user

established by the Minnesota Department of Natural Resources, and (6) descriptors to facilitate water-use-trend analysis.

The water-resources information system is easy to use. Interactive menu-driven programs simplify data entry, update, and retrieval of information. Provisions are made for separating estimates of unreported or unpermitted water-use from reported use. Aggregates of water use by county and watershed are programmed for transfer to the National Water Use Data System in Reston, Va.

Water appropriators are required to report monthly water use on an annual basis to the Minnesota Department of Natural Resources. However, reports from 10 to 20 percent of the permit holders are missing in any given year. Missing reports and unpermitted water use can amount to 40 percent of total water use. Because of this, methods for estimating unreported water use were developed for each of the major use types; municipal, self-supplied industrial, irrigation, rural-domestic, and livestock.

The Minnesota Water Use Data System is designed to provide access to data on the hydrologic system and the stress applied to the system through water withdrawals and discharges that will assist in management of the State's water resources. The availability of data through MWUDS is greatly increased by links to data contained in other State water-related data bases, forming a water-resource information system.

New techniques are being developed to improve the accuracy of reported data and estimates of unreported water use. Several years likely will be needed to refine values of reported and estimated water use. The U.S. Geological Survey's involvement in this program will be to assist in the development of methods.

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APPENDIX A

WATER-USE DATA BASE DESCRIPTION

Data Element: ANNUAL VOLUME APPROPRIATED
Description: The volume of water appropriated by each installation as recorded on the annual water-use reports, expressed in million gallons per year.
Datafile Source: REPORTED.PUMPAGE
Item Name: AN.VOL.APPROP DECIMAL 9(12).9(1)-999999999999.9

Data Element: ANNUAL VOLUME DISCHARGED
Data Description: The volume of water discharged into a lake or river as reported with the NPDES number to the MPCA, expressed in million gallons per year.
Datafile Source: REPORTED.PUMPAGE
Item Name: AN.DISCH Decimal 9(12).9(1)-999999999999.9

Data Element: COMPLAINT FLAG
Description: A complaint has been received by the DNR on this permit.
Datafile Source: WATER.USE.MAIN
Item Name: COMPLAINT Character 1 (X)

Data Element: COUNTY NUMBER
Description: State county numbers are assigned alphabetically below.
Datafile Source: COMMON.FILE
Item Name: COUNTY Integer 2

State County Name & no.	Federal no.	State County Name & no.	Federal no.
01 Aitkin	001	45 Marshall	089
02 Anoka	003	46 Martin	091
03 Becker	005	47 Meeker	093
04 Beltrami	007	48 Mille Lacs	095
05 Benton	009	49 Morrison	097
06 Big Stone	011	50 Mower	099
07 Blue Earth	013	51 Murray	101
08 Brown	015	52 Nicollet	103
09 Carlton	017	53 Nobles	105
10 Carver	019	54 Norman	107
11 Cass	021	55 Olmsted	109
12 Chippewa	023	56 Otter Tail	111
13 Chisago	025	57 Pennington	113
14 Clay	027	58 Pine	115
15 Clearwater	029	59 Pipestone	117
16 Cook	031	60 Polk	119
17 Cottonwood	033	61 Pope	121
18 Crow Wing	035	62 Ramsey	123
19 Dakota	037	63 Red Lake	125
20 Dodge	039	64 Redwood	127
21 Douglas	041	65 Renville	129
22 Faribault	043	66 Rice	131
23 Fillmore	045	67 Rock	133

24 Freeborn	047	68 Roseau	135
25 Goodhue	049	69 St. Louis	137
26 Grant	051	70 Scott	139
27 Hennepin	053	71 Sherburne	141
28 Houston	055	72 Sibley	143
29 Hubbard	057	73 Stearns	145
30 Isanti	059	74 Steele	147
31 Itasca	061	75 Stevens	149
32 Jackson	063	76 Swift	151
33 Kanabec	065	77 Todd	153
34 Kandiyohi	067	78 Traverse	155
35 Kittson	069	79 Wabasha	157
36 Koochiching	071	80 Wadena	159
37 Lac Qui Parle	073	81 Waseca	161
38 Lake	075	82 Washington	163
39 Lake of the Woods	077	83 Watonwan	165
40 Le Sueur	079	84 Wilkin	167
41 Lincoln	081	85 Winona	169
42 Lyon	083	86 Wright	171
43 McLeod	085	87 Yellow Medicine	173
44 Mahnomen	087		

Data Element: CROP ACREAGE
Description: The number of acres of a specified crop type irrigated with the water appropriated under this permit, as recorded on the annual water-use reports.
Datafile Source: REPORTED.PUMPAGE
Item Name: CROP.ACRE1 Integer 4 CROP.ACRE2, CROP.ACRE3 Integer 3

Data Element: CROP IRRIGATED
Description: The crop type irrigated with water appropriated under this permit, as recorded on the annual water-use reports.
Datafile Source: REPORTED.PUMPAGE
Item Name: CROP.IRR1 Integer 4 CROP.IRR2, CROP.IRR3 Integer 3

The Codes are:

10. Specialty
11. Berries
12. Vegetables
13. Experimental Plots

20. Canning
21. Sweet Corn
22. Beans
23. Peas

30. Row Crops
31. Corn
32. Potatoes
33. Sugar Beets
34. Soybeans
35. Sunflowers
36. Dried Beans

40. Field
41. Wheat
42. Other small grains
43. Alfalfa
44. Pasture
45. Wild Rice

80. Non-Crop Irrigation
81. Golf course
82. Cemetary
83. Landscaping
84. Sod
85. Nursery
86. Orchard

Data Element: DAILY DISCHARGE RATE
Description: The volume of water discharged into a lake or river as reported with the NPDES number to the MPCA, expressed in million gallons per day.
Datafile Source: REPORTED.PUMPAGE
Item Name: DAILY.DISCH Decimal 9(3).9(4)-999.9999

Data Element: DISCHARGE WATER BODY
Description: The water body that the appropriated water is discharged to after use, especially important for lake-level maintenance and dewatering uses.
Datafile Source: WATER.USE.MAIN
Item Name: DISCH.WTRBDY Character 15

Codes are:

Rname	OR	R99-9-99-9-9	River name OR River kilometer index no. for stream or ditch.
Lname	OR	L999999	Lake name OR Public Waters Inventory Lake Number.
P	OR	P99-99-99-9-9	Pond OR Minor watershed no. of holding pond.
		SMN9999999	NPDES number of municipal sewage system.
		DF OR DF9999	Drainfield or Minor watershed no. of drainfield, cess pool, or ground on which the water is disposed.
		CR	Partially consumed, unconsumed portion returned to river (ie. wild rice irrigators
		C	Completely consumed (ie. non-wild rice irrigators).

Data Element: DOMESTIC WELL INFORMATION FLAG
Description: Information on local domestic wells is in DNR permit file.
Datafile Source: WATER.USE.MAIN
Item Name: DOM.INFO Character 1 (X)

Data Element: DNR ACTIVE PERMITS FOR THE SAME USER
Description: The active DNR permit number issued for the same facility, followed by a number to indicate the number of active permits held by the same user.
Datafile Source: WATER.USE.PERM
Item Name: DNR.ACT.SAME Integer 7

Data Element: DNR INACTIVE PERMIT NUMBER
Description: Used to indicate the inactive DNR permit number associated with this permit.
Datafile Source: WATER.USE.MAIN
Item Name: DNR.IN.PER# Integer 6

Data Element: EAST RANGE
Description: The letter "E" is assigned to this field when the public land survey shifts to east ranges. This shift only affects permits in the north-east portion of Cook County. For all remaining permits this field is blank.
Datafile Source: COMMON.FILE
Item Name: EAST.RNG Character 1

Data Element: GEN USE
Description: General-use category. A multiple of 10 as defined in the use code data element.
Datafile Source: COMMON.FILE
Item Name: GEN.USE Integer 2

Data Element: GOVERNMENT LOT
Description: A legally defined parcel of land usually adjacent to a meandered lake or stream that contains more or less than 40 acres (roughly equivalent to a quarter-quarter sect.)
Datafile Source: WATER.USE.MAIN
Item Name: GLOT Integer 2

Data Element: HEALTH MUNICIPAL ID
Description: Minnesota Department of Health municipal identification number.
Datafile Source: WATER.USE.MAIN
Item Name: HEALTH.ID Integer 7

Data Element: INSTALLATION CODE
Description: An alphanumeric identification assigned to each point of taking for a DNR permit, used to correlate with the annual water-use reports. It can be a well for ground-water sources, or an intake pipe for surface-water sources.
Datafile Source: COMMON.FILE, WATER.USE.MAIN, REPORTED.PUMPAGE, MO.PUMP
Item Name: INST.CODE Character 4

Data Element: LATITUDE
Description: The location of the installation measured in degrees north of the equator.
Datafile Source: COMMON.FILE
Item Name: LAT Integer 6

Data Element: LAST UPDATE DATE
Description: The month, day, and year the computer file was last updated.
Datafile Source: COMMON.FILE, WATER.USE.MAIN, WATER.USE.PERM
REPORTED.PUMPAGE, MO.PUMP
Item Name: LAST.DATE Date 8 99/99/99

Data Element: LOCATION CONFIDENCE LEVEL
Description: A numeric value that reflects the accuracy of the public land survey data (township-range-section)
Datafile Source: COMMON.FILE
Item Name: CONFID.LEV Integer 1

Codes are:
1. MGS field location
2. USGS field location
3. DNR field location
4. Map location
5. Permit file

Data Element: LONGITUDE
Description: The location of the installation measured in degrees west of the prime meridian.
Datafile Source: COMMON.FILE
Item Name: LONG Integer 7

Data Element: MANIFOLDED WELLS
Description: Indicates that the wells under this permit are manifolded.
Datafile Source: WATER.USE.PERM
Item Name: MANIFOLD Character 1 (M or X)

Data Element: MAP PLOT CHECK
Description: Installation has been plotted on a topographic quadrangle map.
Datafile Source: WATER.USE.MAIN
Item Name: PLOT.CHECK Character 1 (X)

Data Element: MEASUREMENT ACCURACY
Description: A number code assigned to the annual water-use report to reflect the way the water source has been monitored.
Datafile Source: REPORTED.PUMPAGE, MO.PUMP
Item Name: MEAS.ACC Integer 1

Codes are:
1. flow meter
2. timing device
3. estimated
4. other method or zero appropriation
5. calculated by NWUDS (Nat'l Water Use Data System)
6. No report, although required
7. Report not required

Data Element: MONTHS OF DISCHARGE
Description: The number of months that water was discharged as reported with the NPDES number to the MPCA.
Datafile Source: REPORTED.PUMPAGE
Item Name: MNTHS.DISCH Integer 2

Data Element: MONTHLY PUMPAGE
Description: The monthly volume of water appropriated by each installation as recorded on the annual water-use report, expressed in million gallons per month.
Datafile Source: MO.PUMP
Item Name: M01 - M12 Decimal 9(12).9(1)-999999999999.9

Data Element: MUNICIPAL PRECENTAGE SUPPLIED TO COMMERCE & INDUSTRY
Description: Percentage of water supplied by a municipality to commerce and industry.
Datafile Source: WATER.USE.PERM
Item Name: MUN%.COMIND Integer 2

Data Element: NPDES CODE
Description: The National Pollutant Discharge Elimination System permit number assigned the facility and under which discharge is reported to the MPCA.
Datafile Source: WATER.USE.MAIN
Item Name: NPDES.CD Character 9

Data Element: NUMBER OF INSTALLATIONS ON PERMIT
Description: The total number of installations for which the permit has been issued.
Datafile Source: WATER.USE.PERM
Item Name: NUM.INSTS Integer 2

Data Element: PERMIT HOLDER, CURRENT
Description: The name of the current permit holder. The permit holder can be an individual property owner, a company, or governmental unit.
Datafile Source: COMMON.FILE
Item Name: PERM.HOLD Character 25

Data Element: PERMIT NUMBER
Description: The Minnesota Department of Natural Resources - Division of Waters appropriation permit application number.
Datafile Source: COMMON.FILE, WATER.USE.MAIN, WATER.USE.PERM
REPORTED.PUMPAGE, MO.PUMP
Item Name: PERMIT# Integer 6

Data Element: POPULATION SERVED
Description: Approximate population supplied by the municipality.
Datafile Source: WATER.USE.PERM
Item Name: POP.SERVE Integer 6

Data Element: QUADRANGLE
Description: An alphanumeric code that corresponds to the topographic quadrangle on which the installation is located.
Datafile Source: COMMON.FILE
Item Name: QUAD Character 4

Data Element: QUARTER
Description: The installation is located to the nearest quarter-quarter-quarter-quarter section where possible. Each quarter is described by an alphabetic code A, B, C, or D representing the NE, NW, SW, and SE quarters, and is ordered from largest to smallest quarter.
Datafile Source: COMMON.FILE
Item Name: QQQQ Character 4

Data Element: RANGE
Description: The installation's land survey range number.
Datafile Source: COMMON.FILE
Item Name: RNG Integer 2

Data Element: REGION
Description: The DNR has designated counties into six (6) regional areas.
Datafile Source: COMMON.FILE
Item Name: REG Integer 2

REGION 1

3 Becker
4 Beltrami
14 Clay
15 Clearwater
21 Douglas
26 Grant
29 Hubbard
35 Kittson
39 Lake O'Woods
44 Mahnomen
45 Marshall
54 Norman
56 Otter Tail
57 Pennington
60 Polk
61 Pope
63 Red Lake
68 Roseau
75 Stevens
78 Traverse
84 Wilkin

REGION 2

1 Aitkin
9 Carlton
16 Cook
31 Itasca
36 Koochiching
38 Lake
69 St. Louis

REGION 3

5 Benton
11 Cass
13 Chisago
18 Crow Wing
30 Isanti
33 Kanabec
48 Mille Lacs
49 Morrison
58 Pine
71 Sherburne
73 Stearns
77 Todd
80 Wadena
86 Wright

REGION 4

6 Big Stone
7 Blue Earth
8 Brown
12 Chippewa
17 Cottonwood
22 Faribalut
32 Jackson
34 Kandiyohi
37 Lac Qui Parle
40 Le Sueur
41 Lincoln
42 Lyon
43 McLeod
46 Martin
47 Meeker
51 Murray
52 Nicollet
53 Nobles
59 Pipestone
64 Redwood
65 Renville
67 Rock
72 Sibley
76 Swift
81 Waseca
83 Watonwan
87 Yellow Medicine

REGION 5

20 Dodge
23 Fillmore
24 Freeborn
25 Goodhue
28 Houston
50 Mower
55 Olmsted
66 Rice
74 Steele
79 Wabasha
85 Winona

REGION 6

2 Anoka
10 Carver
19 Dakota
27 Hennepin
62 Ramsey
70 Scott
82 Washington

Data Element: REMARKS
Description: Any special permit provisions or information that is not coded in a particular category. The remarks may also help to clarify entries made in other components.
Datafile Source: WATER.USE.PERM
Item Name: REMARKS Character 30

Data Element: REPORT YEAR
Description: The year in which appropriation or discharge occurred.
Datafile Source: REPORTED.PUMPAGE
Item Name: REP.YR Integer 2

Data Element: RESOURCE CODE
Description: A code that identifies the source from which water is appropriated. These codes correspond to the Master Permit Index source type codes and the Annual Mailing List codes.
Datafile Source: COMMON.FILE, WATER.USE.MAIN
Item Names: RESOURCE.CODE(in common.file) & RESOURCE.CD(in use-main) Character 1

Codes are:

1 - Groundwater
2 - Lake
3 - Stream
4 - Ditch
5 - Dug pit
6 - Pond
7 - Slough
8 - Quarry/Gravel pit
9 - Wetland

Data Element: RESOURCE IDENTIFICATION
Description: Name of resource and if available lake number, stream identification, minor watershed number in which the pit, pond, or slough is located, or aquifer code from which the water is appropriated.
Datafile Source: WATER.USE.MAIN
Item Name: RESC.NUM Character 15

Data Element: SECTION
Description: The installation's public land survey section number.
Datafile Source: COMMON.FILE
Item Name: SECT Integer 2

Data Element: SERVICE CONNECTIONS
Description: The number of service connections supplied by the municipal water works.
Datafile Source: WATER.USE.PERM
Item Name: SERVICE.CONN Integer 6

Data Element: SPECIAL PROVISION FLAG
Description: Identifies the type of special provisions that are included when the permit is issued or amended.
Datafile Source: WATER.USE.MAIN
Item Name: SPEC.PROV Character 1

Codes are:
1. A special provision attached to certain ground-water permits that requires the permit holder to periodically measure and report the water levels of the well.
2. Well is in the Water-Level -Observation Well Network.
3. Both 1 and 2 are true.
4. Protected elevation.
5. Protected flow.
X. Other special provisions exist.

Data Element: STANDARD INDUSTRIAL CLASSIFICATION CODE
Description: A unique four-digit code assigned to non-irrigation water appropriation permits based on type of industrial activity.
Datafile Source: WATER.USE.PERM
Item Name: SIC Integer 4

Data Element: STANDARD INDUSTRIAL CLASSIFICATION CODE FLAG
Description: Indicates that more than one SIC code was originally assigned.
Datafile Source: WATER.USE.PERM
Item Name: SIC.FLAG Character 1

Data Element: STANDARD INDUSTRIAL CLASSIFICATION CODE - MULTIPLE CODE
Description: Indicates an additional SIC code is associated with this permit pertaining to the non-major use of the facility.
Datafile Source: WATER.USE.PERM
Item Name: MULT.SIC Integer 4

Data Element: TERMINATION DATE
Description: The date the permit was terminated.
Datafile Source: WATER.USE.PERM
Item Name: TERM.DATE Character 8 99/99/99

Data Element: TOTAL PERMITTED APPROPRIATION
Description: Total maximum volume of water that can be appropriated by all installations under this DNR permit.
Datafile Source: WATER.USE.PERM
Item Name: TOT.APPROP Decimal 9(12).9(1)-999999999999.9

Data Element: TOTAL PERMITTED PUMPING RATE
Description: Total maximum rate of pumpage in gallons per minute that is permitted by all installations under this DNR permit.
Datafile Source: WATER.USE.PERM
Item Name: PUMP.RATE Decimal 9(6).9(1)-999999.9

Data Element: TOTAL PERMITTED ACREAGE FOR PERMIT
Description: Total maximum acreage that can be irrigated by all installations under this permit.
Datafile Source: WATER.USE.PERM
Item Name: TOT.ACRE Integer 4

Data Element: TOTAL PERMITTED DISCHARGE FOR PERMIT
Description: Total maximum volume of water that can be discharged by all installations under the NPDES permit.
Datafile Source: WATER.USE.PERM
Item Name: TOT.DISCH Decimal 9(12).9(1)-999999999999.9

Data Element: TOWNSHIP
Description: The installation's public land survey township number.
Datafile Source: COMMON.FILE
Item Name: TWP Integer 3

Data Element: UNIQUE WELL NUMBER
Description: A unique six-digit number that since 1975 is assigned by the MDH for new wells or the MGS for existing wells to the well log of a particular well.
Datafile Source: COMMON.FILE, WATER.USE.MAIN, REPORTED.PUMPAGE
Item Name: UNIQ# Integer 6

Data Element: USECODE
Description: This use designation corresponds to the Regional Water Data Network and the Annual Mailing List Codes.
Datafile Source: COMMON.FILE
Item Name: USE.CODE Integer 2

Use Codes are:

WATERWORKS

10. Waterworks
 11. Municipal Waterworks
 12. Private Waterworks (trailer courts, small housing units).
 13. Commercial and Institutional
 14. Cooperative waterworks
 15. Fire protection
 16. State Parks, waysides, highway rest areas

TEMPORARY

50. Temporary
 51. Construction (non-dewatering)
 52. Construction (dewatering)
 53. Pipeline & Tank Testing
 54. Landscape watering

POWER GENERATION

20. Power Generation
 21. Hydropower
 22. Steam Power Cooling -once through
 23. Steam Power Cooling -wet tower
 24. Steam Power Cooling -ponds
 25. Steam Power - other than cooling

WATER-LEVEL MAINTENANCE

60. Water-Level Maintenance
 61. Basin (lake) Level
 62. Mine Dewatering
 63. Quarry Dewatering
 64. Sand/Gravel Pit Dewatering
 65. Tile drainage and Pumped Sumps

AIR CONDITIONING

30. Air Conditioning
 31. Commercial building
 32. Institutions - school, hospitals
 33. Heat pumps
 34. Coolant pumps
 35. District heating

INDUSTRIAL

40. Industrial processing
 41. Food & Livestock (agric. processing)
 42. Paper/pulp
 43. Mine Processing (other than sand & gravel washing)
 44. Sand and Gravel washing
 45. Sewage treatment
 46. Petroleum - chemical processing
 47. Metal processing
 48. Non-metallic products (rubber, plastic, glass)

MAJOR CROP IRRIGATION

90. Major crop irrigation
 96. Wild rice irrigation

SPECIAL CATEGORIES

 71. Pollution confinement
 72. Hatcheries and fisheries
 73. Snow making
 74. Peat fire control

NON-CROP IRRIGATION

80. Non-crop irrigation
 81. Golf course
 82. Cemetery
 83. Landscaping
 84. Sod
 85. Nursery
 86. Orchard

Data Element: USGS SITE IDENTIFICATION NUMBER
Description: A 15-digit number assigned by the USGS based on the latitude and longitude of the well.
Datafile Source: WATER.USE.MAIN
Item Name: SITE.ID Integer 15

Data Element: WATERSHED UNIT
Description: A two-digit number that corresponds to the DNR watershed in which the well is located. These watersheds are compatible with the detailed watersheds of the Watershed Mapping Project and can be aggregated into the USGS hydrologic units that divide the state into major drainage basins.
Datafile Source: COMMON.FILE
Item Name: WATSHD.UNIT Integer 2

Western Lake Superior

1 Baptism Brule
2 Beaver-Lester
3 St. Louis
4 Cloquet
5 Beartrap-Nemadji

Mississippi River Headwaters

7 Mississippi Headwaters
8 Leech Lake
9 Prairie-Willow
10 Elk-Nokasippi
11 Pine
12 Crow Wing
13 Redeye

Mississippi River
Headwaters (Cont.)

14 Long Prairie
15 Platte-Spunk
16 Sauk
17 Clearwater-Elk
18 Crow
19 South Fork Crow
20 Twin Cities
21 Rum

Minnesota River

22 Upper Minnesota
23 Pomme de Terre
24 Lac qui Parle
25 Hawk-Yellow Medicine
26 Chippewa
27 Redwood
28 Middle Minnesota
29 Cottonwood
30 Blue Earth
31 Watonwan
32 Le Sueur
33 Lower Minnesota

St. Croix River

34 Upper St. Croix
35 Kettle
36 Snake
37 Lower St. Croix

Upper Mississippi

38 Rush-Vermillion
39 Cannon
40 Buffalo-Whitewater
41 Zumbro
42 La Crosse-Pine
43 Root
44 Coon-Yellow
46 Upper Iowa
47 Upper Wapsipinicon
48 Upper Cedar
49 Shell Rock
50 Winnebago

Des Moines River

51 Des Moines Headwaters
52 Upper Des Moines
53 East Fork Des Moines

Red River

54 Boise de Sioux
55 Mustinka
56 Otter Tail
57 Upper Red
58 Buffalo
59 Elm-Marsh
60 Eastern Wild Rice
61 Sandhill-Wilson
62 Red Lakes

Red River (Cont.)

63 Red Lake
65 Thief
66 Clearwater
67 Grand Marais-Red
68 Snake
69 Lower Red
70 Two Rivers
71 Roseau

Rainy River

72 Rainy Headwaters
73 Vermillion
74 Rainy Lake
75 Upper Rainy
76 Little Fork
77 Big Fork
78 Rapid
79 Lower Rainy
80 Lake of the Woods

Missouri River

81 Upper Big Sioux
82 Lower Big Sioux
83 Rock
84 Little Sioux

Data Element: WELL STATUS
Description: Indicates the status of the well.
Datafile Source: COMMON.FILE
Item Name: WELL.STAT Integer 1

Codes are:
1- Active
2- Standby
3- Abandoned
4- Permit terminated
5- Well not under permit - but actively appropriating

Data Element: YEAR
Description: Indicates the year in which water was appropriated as recorded from the annual water-use reports.
Datafile Source: MO.PUMP
Item Name: YEAR Integer 2

WATER.USE.MAIN FILE CONTENT

Variable name	Variable Description	Type	Internal format
UNIQ#	Unique well number	I	6
PERMIT#	Permit Application number	I	6
INST.CODE	Installation (source) number	C	4
RESOURCE.CD	Resource code	I	1
SPEC.PROV	Special provision	C	1
DOM.INFO	Domestic information	C	1
COMPLAINT	Complaint received on permit	C	1
GLOT	Government lot	I	2
PLOT.CHECK	Map plot check	C	1
RESC.NUM	Resource identification	C	15
DNR.IN.PER#	DNR Inactive permit number	I	6
HEALTH.ID	MDH Municipal ID number	I	7
SITE.ID	USGS Site ID number	I	15
NPDES.CD	MPCA discharge permit number	C	9
DISCH.WTRBDY	Discharge waterbody	C	15
LAST.DATE	Date permit was last updated	D	8

WATER.USE.PERM FILE CONTENT

Variable name	Variable Description	Type	Internal format
PERMIT#	Permit application number	I	6
TOT.APPROP	Total annual appropriation	N.1	14
TOT.ACRE	Total acreage irrigated	I	4
TOT.DISCH	Total discharge	N.1	14
TERM.DATE	Termination date of permit	C	8
POP.SERVE	Population served	I	6
SERVICE.CONN	Service connections	I	6
MUN%.COMIND	Municipal % - commerce & industry	I	2
DNR.ACT.SAME	DNR active permits same user	I	7
MANIFOLD	Wells manifolded	C	1
PUMP.RATE	Permitted pumping rate	N.1	8
NUM.INSTS	Number of installations for permit	I	2
LAST.DATE	Date permit was last updated	D	8
SIC	Standard Industrial Classifi. Code	I	4
SIC.FLAG	Indicates more than one SIC Code	C	1
MULT.SIC	Multiply SIC code issued	I	4
REMARKS	Remarks	C	30

COMMON.FILE FILE CONTENT

Variable name	Variable Description	Type	Internal format
UNIQ#	Unique well number	I	6
PERMIT#	Permit application number	I	6
INST.CODE	Installation (source) number	C	4
PERM.HOLD	Permit Holder	C	25
USE.CODE	Use code	I	2
COUNTY	County number	I	2
WATSHD.UNIT	Watershed location number	I	2
TWP	Township location	I	3
RNG	Range location	I	2
EAST.RNG	East range location	C	1
SECT	Section location	I	2
QQQQ	Quarter section location	C	4
QUAD	Quadrangle alphanumeric code	C	4
CONFID.LEV	Confidence level (location)	I	1
LAT	Latitude	I	6
LONG	Longitude	I	7
RESOURCE.CODE	Resource code	I	1
GEN.USE	General use	I	2
REG	Region number	I	2
LAST.DATE	Date permit last updated	D	8
WELL.STATUS	Status of well	I	1

REPORTED.PUMPAGE FILE CONTENT

Variable name	Variable Description	Type	Internal format
UNIQ#	Unique number of well		
PERMIT #	Permit application number	I	6
INST.CODE	Installation (source) number	C	4
REP.YR	Year of appropriation or discharge	I	2
MEAS.ACC	Measurement accuracy	I	1
AN.VOL.APPROP	Annual vol.appropriated (reported)	N.1	14
CROP.ACRE1	Crop acreage (reported)	I	4
CROP.IRR1	Crop type irrigated (reported)	I	2
CROP.ACRE2	Crop acreage (reported	I	3
CROP.IRR2	Crop type irrigated (reported)	I	2
CROP.ACRE3	Crop acreage (reported)	I	3
CROP.IRR3	Crop type irrigated (reported)	I	2
DAILY.DISCH	Daily discharge (reported mgd)	N.4	8
MNTHS.DISCH	Months of discharge (reported)	I	2
AN.DISCH	Annual discharge (reported mgy)	N.1	14
LAST.DATE	Date permit last updated	D	8

MO.PUMP FILE CONTENT

Variable name	Variable Description	Type	Internal format
YEAR	Year of appropriation	I	2
PERMIT#	Permit application number	I	6
INST.CODE	Installation (source) number	C	4
MEAS.ACC	Measurement accuracy	I	1
M01	Month Jan. (vol.reported)	N.1	14
M02	Month Feb. (vol.reported)	N.1	14
M03	Month March (vol.reported)	N.1	14
M04	Month April (vol.reported)	N.1	14
M05	Month May (vol.reported)	N.1	14
M06	Month June (vol.reported)	N.1	14
M07	Month July (vol.reported)	N.1	14
M08	Month Aug. (vol.reported)	N.1	14
M09	Month Sept. (vol.reported)	N.1	14
M10	Month Oct. (vol.reported)	N.1	14
M11	Month Nov. (vol.reported)	N.1	14
M12	Month Dec. (vol.reported)	N.1	14
LAST.DATE	Date permit last updated	N.1	14

APPENDIX B

GROUND-WATER DATA BASE DESCRIPTION

Element Descriptions

Data Element:	UNIQUE WELL NUMBER	
Description:	A unique six-digit number assigned by the MGS to each well that has a well log. These numbers are automatically assigned to wells drilled since 1975 by printing the unique number on the MDH forms that are filled in by the driller when a well is drilled. Older wells with logs are assigned unique numbers by the MGS.	
Datafile Source:	COMMON.FILE	
Item Name:	UNIQ#	Integer 6

Data Element:	PERMIT NUMBER	
Description:	The Minnesota Department of Natural Resources Division of Waters appropriation permit application number.	
Datafile Source:	COMMON.FILE, GWDB	
Item Name:	PERMIT#	Integer 6

Data Element:	INSTALLATION CODE	
Description:	An alphanumeric identification assigned to each well, used in conjunction with DNR permit to uniquely identify it and to correlate with the annual water-use reports.	
Datafile Source:	COMMON.FILE, GWDB	
Item Name:	INST.CODE	Character 4

Data Element:	PERMIT HOLDER, CURRENT	
Description:	The name of the current permit holder. The permit holder can be an individual property owner, a company, or governmental unit. In most cases the name that appears in this component is the one who is responsible for submitting annual water-use reports.	
Datafile Source:	COMMON.FILE	
Item Name:	PERM. HOLD	Character 25

Data Element: USE CODE
Description: This use designation corresponds to the Regional Water Data Network and the permit-application-form use codes.
Datafile Source: COMMON.FILE
Item Name: USE.CODE Integer 2

Use Codes are:

WATERWORKS
10. Waterwork
 11. Municipal Waterworks
 12. Private Waterworks (trailer courts, small housing units)
 13. Commercial and institutional
 14. Cooperative waterworks
 15. Fire protection
 16. State Parks, waysides, etc.

POWER GENERATION
20. Power generation
 21. Hydropower
 22. Steam Power Cooling - once through
 23. Steam Power Cooling - Wet tower
 24. Steam Power cooling - ponds
 25. Steam Power - uses other than cooling

AIR CONDITIONING
30. Air conditioning
 31. Commercial building
 32. Institutions - schools, hospitals
 33. Heat Pumps
 34. Coolant Pumps
 35. District heating

INDUSTRIAL
40. Industrial Processing
 41. Food and Livestock (agric. processing)
 42. Paper/Pulp
 43. Mine Processing (other than sand & gravel washing)
 44. Sand and Gravel Washing
 45. Sewage Treatment
 46. Petroleum - Chemical Processing
 47. Metal Processing
 48. Non-metallic products (rubber, plastic, glass)

TEMPORARY
50. Temporary
 51. Construction (non-dewatering)
 52. Construction dewatering
 53. Pipeline and Tank Testing
 54. Landscape Watering

WATER-LEVEL MAINTENANCE
60. Water-Level Maintenance
 61. Basin (Lake) Level
 62. Mine Dewatering
 63. Quarry Dewatering
 64. Sand/Gravel Pit Dewatering
 65. Tile drainage and Pumped Sumps

SPECIAL CATEGORIES
 71. Pollution confinement
 72. Hatcheries and Fisheries
 73. Snow Making
 74. Peat Fire Control

NON-CROP IRRIGATION
80. Non-crop Irrigation
 81. Golf Course
 82. Cemetery
 83. Landscaping
 84. Sod
 85. Nursery
 86. Orchard

MAJOR CROP IRRIGATION
90. Major Crop Irrigation
 96. wild rice

Data Element: COUNTY NUMBER
Description: State county numbers are assigned alphabetically (see page 30).
Datafile Source: COMMON.FILE
Item Name: COUNTY Integer 2

Data Element: WATERSHED UNIT
Description: A two-digit number that corresponds to the Department of Natural Resources watershed in which the well is located. These watersheds are compatible with the detailed watersheds of the Watershed Mapping Project and can be aggregated into the U.S. Geological Survey hydrologic units that divide the state into major drainage basins (see page 40).
Datafile Source: COMMON.FILE
Item Name: WATSHD.UNIT Integer 2

Data Element: TOWNSHIP
Description: The well's public land survey township number.
Datafile Source: COMMON.FILE
Item Name: TWP Integer 3

Data Element: RANGE
Description: The well's public land survey range number.
Datafile Source: COMMON.FILE
Item Name: RNG Integer 2

Data Element: EAST RANGE
Description: The letter "E" is assigned to this field when the public land survey shifts to east ranges. This shift only affects permits in the north-east portion of Cook County (county number 16). For all remaining permits this field is blank.
Datafile Source: COMMON.FILE
Item Name: EAST.RNG Character 1

Data Element: SECTION
Description: The well's public land survey section number.
Datafile Source: COMMON.FILE
Item Name: SECT Integer 2

Data Element: QUARTER
Description: The well is located to the nearest quarter-quarter-quarter-quarter section where possible. Each quarter is described by an alphabetic code A, B, C, or D representing the northeast, northwest, southwest, and southeast quarters, respectively, and is ordered from the largest to smallest quarter.
Datafile Source: COMMON.FILE
Item Name: QQQQ Character 4

Data Element: QUADRANGLE
Description: An alphanumeric code that corresponds to the USGS topographic quadrangle on which the well is located. Code is found on the topographic index map.
Datafile Source: COMMON.FILE
Item Name: QUAD Character 4

Data Element: LOCATION CONFIDENCE LEVEL
Description: A numeric value that reflects the accuracy of the public land survey data (township-range-section).
Datafile Source: COMMON.FILE
Item Name: CONFID.LEV Integer 1
Codes are:
1 - Field location
2 - Address location
3 - Unlocated

Data Element: LATITUDE
Description: The location of the well measured in degrees north of the equator.
Datafile Source: COMMON.FILE
Item Name: LAT Integer 6

Data Element: LONGITUDE
Description: The location of the well measured in degrees west of the prime meridian.
Datafile Source: COMMON.FILE
Item Name: LONG Integer 7

Data Element: LAND-SURFACE ELEVATION
Description: Elevation of land surface at site of the well, in feet above mean sea level (MSL). Determined from topographic map unless given in permit.
Datafile Source: GWDB
Item Name: SURF.ELEV Integer 4

Data Element: LAND-SURFACE-ELEVATION ACCURACY
Description: A numeric value that reflects the accuracy of the reported elevation.
Datafile Source: GWDB
Item Name: SURF.ELEV-ACC Integer 1
Codes are:
1 - Interpolated from topographic map.
2 - Interpolated from topographic map after being field located.
3 - Level or other survey method; this type of measurement can be recognized because the elevation is reported to the hundredth of a foot.

Data Element: WELL STATUS
Description: Indicates the status of the well.
Datafile Source: GWDB
Item Name: WELL.STAT Integer 1
Codes are:
1 - Active
2 - Standby (Inactive)
3 - Abandoned (according to MDH code)

Data Element: WELL TYPE
Description: Numeric code assigned to the specific well type.
Datafile Source: GWDB
Item Name: WELL.TYPE Integer 1
Codes are:
1 - Water level is above the land surface.
2 - Water level is above the top of the aquifer but below land surface.
3 - Water level is below the top of the aquifer.

Data Element: MULTI-SINGLE AQUIFER
Description: Indicates whether water is being drawn from one or from more than one aquifer.
Datafile Source: GWDB
Item Name: MULT/SING-AQUIF Character 1
Codes are:
S - Single aquifer
M - Multiple aquifer

Data Element: AQUIFER TEST
Description: Y indicates an aquifer test was performed.
Datafile Source: GWDB
Item Name: AQUIF.TEST Character 1

Data Element: WELL LOG TYPE
Description: Indicates the type of well log available for the well.
Datafile Source: GWBD
Item Name: WELL.LOG-TYPE Integer 1
Codes are:
1 - Geologic sample
2 - USGS or MGS interpreted log
3 - Uninterpreted drillers log
4 - Geophysical
5 - None

Data Element: WATER LEVEL FLAG
Description: 1 - A special provision attached to certain ground-water permits that requires the permit holder to periodically measure and report the water levels of the well.
2 - Well is in the Water-Level-Observation Well Network.
3 - Both 1 and 2 are true.
Datfile Source: GWBD
Item Name: WAT.LEVEL-FLAG Integer 1

Data Element: YEAR CONSTRUCTED
Description: Year in which the well was drilled; obtained from the well log.
Datafile Source: GWDB
Item Name: YR.CONST Integer 4

Data Element: WELL DRILLER
Description: The name of the drilling company that drilled the well.
Datafile Source: GWDB
Item Name: DRILLER Character 25

Data Element: WELL DEPTH, LSD
Description: Actual depth of the well in feet below land surface datum, obtained from the well log when available, otherwise from permit file.
Datafile Source: GWDB
Item Name: DEPTH-LSD Integer 4

Data Element: WELL DEPTH, MSL
Description: Actual depth of the well expressed in terms of mean sea level. Elevations below MSL should be preceded by a minus (-) sign. Obtained from the well log when available, otherwise from permit file.
Datafile Source: GWDB
Item Name: DEPTH-MSL Integer 5

Data Element: WELL DEPTH SOURCE
Description: Designates the source of the recorded depth and diameter.
Datafile Source: GWDB
Item Name: DEPTH-SOURCE Character 1
Codes are:
1 - Drillers log.
2 - Geophysical log.
3 - Video log.
4 - Sounding measurement.
5 - Estimated.

Data Element: MGSLOG
Description: Y - Checked against the well data contained in the MGS water-well data base.
Datafile Source: GWDB
Item Name: MGS.LOG Character 1

CASING

Pipe placed inside the open hole of a well to prevent the sides from caving in, and to prevent water from more than one aquifer from entering the well. There are two main types of casing construction:

Telescoping - casing which overlaps into successively smaller diameter pipes.

Stepdown - casing which has an outer and inner (liner) casing, both from the surface.

Each casing unit should be described separately, largest diameter first, up to five casings.

Data Element: CASING MATERIAL
Description: Type of material from which casing is made.
Datafile Source: GWDB
Item Name: CAS1-MAT, CAS2-MAT, CAS3-MAT, CAS4-MAT, CAS5-MAT
Integer 1

Codes are:
1 - Wrought Iron
2 - Tile
3 - Concrete
4 - Plastic (PVC)
5 - Steel
6 - Other

Most casings for high capacity wells are now steel. Older well casings were usually wrought iron (black steel).

Data Element: CASING DIAMETER
Description: The diameter of the well casing given in inches and obtained from the well log.
Datafile Source: GWDB
Item Name: CAS1-DIA, CAS2-DIA, CAS3-DIA, CAS4-DIA, CAS5-DIA
Integer 3

Data Element: CASED FROM MSL
Description: The top of the casing unit. In stepdown casing, each casing top will coincide with the land surface elevation. Expressed as the vertical distance in feet from mean sea level.
Datafile Source: GWDB
Item Name: CAS1-FROMMSL, CAS2-FROMMSL, CAS3-FROMMSL, CAS4-FROMMSL, CAS5-FROMMSL
Integer 4

Data Element: CASED TO MSL
Description: The bottom of the casing unit expressed as the vertical distance in feet from mean sea level.
Datafile Source: GWDB
Item Name: CAS1-TOMSL, CAS2-TOMSL, CAS3-TOMSL, CAS4-TOMSL, CAS5-TOMSL
Integer 4

OPENINGS

Describes the portion of the well that is uncased. This may be some type of screen or open hole, up to two openings.

Data Element: OPENING TYPE
Description: Indicates type of opening.
Datafile Source: GWDB
Item Name: OPEN1-TYPE, OPEN2-TYPE Integer 1
Codes are:
1 - Open hole
2 - Wire wound screen
3 - Mesh screen
4 - Perforated, porous, slotted casing
5 - Louvered
6 - Sand point
7 - Screen, type unknown
8 - Other

Data Element: OPENING MATERIAL
Description: Indicates the type of screen material.
Datfile Source: GWDB
Item Name: OPEN1-MAT, OPEN2-MAT Integer 1
Codes are:
1 - Stainless steel
2 - PVC, fiberglass, plastic
3 - Wrought iron
4 - Steel
5 - Other
One of the most common screen types is the Johnson stainless steel wire-wound screen. The louvered screen is most common in gravel-packed wells.

Data Element: OPENING DIAMETER
Description: Diameter, in inches, of perforated or slotted pipe, diameter of screen, or diameter of hole if well is open-hole.
Datafile Source: GWDB
Item Name: OPEN1-DIA, OPEN2-DIA Integer 3

Data Element: OPENING SLOT-GAUGE
Description: Slot size or mesh size, given in .001 of an inch, e.g. 150.
Datafile Source: GWDB
Item Name: OPEN1-SLOT.GAUGE, OPEN2-SLOT.GAUGE Integer 3

Data Element: OPENING TOP MSL
Description: Top of the open section expressed as the vertical distance in feet from mean sea level.
Datafile Source: GWDB
Item Name: OPEN1-TOP, OPEN2-TOP Integer 4

Data Element: OPENING BOTTOM MSL
Description: Bottom of the open section expressed as the vertical distance in feet from mean sea level.
Datafile Source: GWDB
Item Name: OPEN1-BOT, OPEN2-BOT Integer 4

PUMP

Up to two installed pumps.

Data Element: PUMP TYPE
Description: Type of pump installed at the well.
Datafile Source: GWDB
Item Name: PUMP1-TYPE, PUMP2-TYPE Integer 1
Codes are:

1. Air - type of lift in which a jet of air pumped below the water table causes a stream of mixed air and water to issue from the well.
2. Bucket - includes the familiar "rope and bucket", chain and bucket lifts, and the small bailer lifted by a rope or chain and pulley.
3. Centrifugal - rotating impellers in a closed chamber that draw the water into the pump. The water is then discharged from the pump, commonly under great pressure, by centrifugal force. Such pumps have maximum lift of about 25 feet but can force water to considerable heights above the pump.
4. Jet - has two pipes extending from the pump into the well. One pipe forces water down the hole under pressure while the other pipe discharges water that has been forced to the surface by the action of the jet. Jet pumps are used principally for small water supplies, such as would be used for a suburban home, farm, or small commercial establishment.
5. Piston - includes the familiar lift and pitcher pumps common in many rural areas. The old "reciprocating" pumps and the "deep-well with walking-bean jacks" are of the piston type.
6. Rotary - operates on the principle that direct pressure is created by squeezing the water between specially designed runners. A relatively high vacuum may be created on the intake side so the suction lift is comparable to that for centrifugal pumps.
7. Submergible- special type of turbine in which an electric motor is connected directly to the impellers and submerged beneath the water. It can be recognized by the presence of insulated electric wire leading into the well and the absence of any pump or powerunit at the surface.

8. Turbine - several types, may be either for a deep or shallow well. A series of impellers, placed below the surface of the water, are rotated by a vertical shaft connected to a power source at the land surface. These impellers "pick up" the water and force it to the surface through the pump column. Such pumps are commonly used to lift large amounts of water at high pressure. They are used in high capacity wells for public, industrial, or irrigation supply.
9. Unknown- site is equipped with a pump about which other data are available, but the type of pump cannot be identified.
10. Other- any lifting device that does not belong in one of the other categories. Examples are: helical rotor, hydraulic ram, and siphon.

Data Element: POWER SOURCE
Description: Number code indicating pump power type.
Datafile Source: GWDB
Item Name: PUMP1-PWRSRC, PUMP2-PWRSRC Integer 1

Codes are:
1 - Diesel
2 - Electricity
3 - Gasoline
4 - Natural Gas
5 - Wind
6 - Other

Data Element: PUMP CAPACITY
Description: The amount of water in gallons per minute the pump can produce when operating at a maximum.
Datfile Source: GWDB
Item Name: PUMP1-CAP, PUMP2-CAP Integer 4

Data Element: HORSEPOWER
Description: Horsepower rating of the primary power source (pump).
Datafile Source: GWDB
Item Name: PUMP1-HRSEPWR, PUMP2-HRSEPWR Integer 4

Data Element: LOWEST INTAKE LEVEL
Description: Lowest level at which the intake of water is possible; the maximum distance the water level can be drawn down before the pump breaks suction.
Datafile Source: GWDB
Item Name: PUMP1-LOWIN, PUMP2-LOWIN Integer 5

Data Element: DATE INSTALLED
Description: The date of the installation of the pump.
Datafile Source: GWDB
Item Name: PUMP1-DATEI, PUMP2-DATEI Character 10

AQUIFER

The water-bearing formation to which the well is open, a screen or open hole, up to four aquifers.

Data Element: AQUIFER LITHOLOGY
Description: General lithology of the material from which the water is being taken such as sand, gravel, sand and gravel, sandstone, or limestone.
Datafile Source: GWDB
Item Name: AQU1-LITH, AQU2-LITH, AQU3-LITH, AQU4-LITH
Character 4

Codes are:
Bedrock:
- DLMT - dolomite
- ICRY - igeneous crystalline rock, i.e. granite, basalt
- LMSN - limestone
- LSSS - limestone-sandstone
- QUZT - quartzite
- SNDS - sandstone

Unconsolidated:
- DRFT - drift
- GRVL - gravel
- SAND - sand
- SDGL - sand and gravel

Data Element: AQUIFER STRATIGRAPHIC UNIT
Description: Four-letter symbol of the stratigraphic unit from which the water is being withdrawn.
Datafile Source: GWDB
Item Name: AQU1-STRAT, AQU2-STRAT, AQU3-STRAT, AQU4-STRAT
Character 4

Data Element: OVERLYING MATERIAL
Description: A numeric code representing the type of material above the aquifer.
Datafile Source: GWDB
Item Name: AQU1-OVMAT, AQU2-OVMAT, AQU3-OVMAT, AQU4-OVMAT
Integer 1

Codes are:
1 - Bedrock aquifer is overlain by sand and (or) gravel.
2 - Bedrock aquifer is overlain by clay.

Data Element: AQUIFER TOP MSL
Description: The vertical distance from mean sea level where the aquifer begins. Given in feet. When the aquifer is the Jordan, use the top of the Jordan as the top of the aquifer. Note in comments section that the Prairie du Chien overlies the Jordan at this location.
Datafile Source: GWDB
Item Name: AQU1-TOP, AQU2-TOP, AQU3-TOP, AQU4-TOP
Integer 5

Data Element: AQUIFER BOTTOM MSL
Description: The vertical distance from mean sea level where the aquifer ends. Given in feet. If the confining bed beneath the aquifer is not encountered, this field remains blank.
Datafile Source: GWDB
Item Name: AQU1-BOT, AQU2-BOT, AQU3-BOT, AQU4-BOT
Integer 5

CONFINING BED

A formation of substantially lower permeability directly overlying the aquifer. Must be over 15 feet thick, up to three confining beds.

Data Element: CONFINING BED LITHOLOGY
Description: General description of the material that makes up the confining bed for the aquifer such as clay or shale. If there is no confining bed, then this field remains blank.
Datafile Source: GWDB
Item Name: CON1-LITH, CON2-LITH, CON3-LITH
Character 4
Codes for confining bed lithologies are:
CLAY - clay
CNGL - conglomerate
DRFT - drift
PEAT - peat
SHLE - shale
SILT - silt
SLTE - slate
TILL - till

Data Element: CONFINING BED STRATIGRAPHIC UNIT
Description: Four-letter symbol of the stratigraphic unit that comprises the confining bed.
Datafile Source: GWDB
Item Name: CON1-STRAT, CON2-STRAT, CON3-STRAT
Character 4

Codes for confining bed stratigraphic units are:
APGW - Platteville - bedrock confining bed for OSTP
CSTL - St. Lawrence - confining bed for CIGL
CECR - Eau Claire - confining bed for CMSH
ODUB - Dubuque - confining bed for OGAL
QCLY - clay
QSLT - silt
QTLL - till
QDFT - drift

Date Element: CONFINING BED TOP MSL
Description: The vertical distance from mean sea level where the confining bed begins, given in feet.
Datafile Source: GWDB
Item Name: CON1-TOP, CON2-TOP, CON3-TOP
Integer 5

Data Element: CONFINING BED BOTTOM MSL
Description: The vertical distance from mean sea level where the confining bed ends, given in feet.
Datafile Source: GWDB
Item Name: CON1-BOT, CON2-BOT, CON3-BOT
Integer 5

DRILLERS PRODUCTION TEST

The pumping test is a minimum of one hour at one pumping rate. This is not the same as an aquifer test that has observation wells, up to two tests.

Data Element: TEST DATE
Description: Date of driller's pumping test.
Datafile Source: GWDB
Item Name: DRIL1-DATE, DRIL2-DATE Character 10

Date Element: TEST LENGTH
Description: Pumping test length. Test length is recorded in hours. This element is required for test group.
Datafile Source: GWDB
Item Name: DRIL1-LGTH, DRIL2-LGTH Integer 4

Data Element: TEST STATIC WATER LEVEL
Description: Water level in well when pump is off, given in feet. If water is below MSL, then it is given a negative (-) value in feet. This element is required for test group.
Datafile Source: GWDB
Item Name: DRIL1-STATLV, DRIL2-STATLV Integer 5

Data Element: TEST PUMPING WATER LEVEL
Description: Water level maintained during pumping test. This element is required for test group.
Datafile Source: GWDB
Item Name: DRIL1-PUMP-WTRLV, DRIL2-PUMP-WTRLV
Integer 5

Data Element: TEST PUMPING RATE
Description: The pumping rate, in gallons per minute, used during the driller's pumping test. Must be a single value for over one hour.
Datafile Source: GWDB
Item Name: DRIL1-PUMP-RATE, DRIL2-PUMP-RATE
Integer 5

WATER-LEVEL MEASUREMENT

This series permits recording up to five water levels for wells in this data base. If there are more than five measurements, then the well should probably be in OBWELL.

Data Element: MEASURING DATE
Description: Date of water-level measurement.
Datafile Source: GWDB
Item Name: WTRLV1-DATE, WTRLV2-DATE, WTRLV3-DATE, WTRLV4-DATE, WTRLV5-DATE Character 10

Data Element: WATER LEVEL MSL
Description: The vertical distance from mean sea level to the water level of the well.
Datafile Source: GWDB
Item Name: WTRLV1-LEVELMSL, WTRLV2-LEVELMSL, WTRLV3-LEVELMSL, WTRLV4-LEVELMSL, WTRLV5-LEVELMSL
Integer 5

Data Element: COMMENTS
Description: Any special permit provisions or information that is not coded in a particular category may be entered in this element. The comments may also help to clarify entries made in other data elements. Up to two comments.
Datafile Source: GWDB
Item Name: COMMENT1, COMMENT2 Character 30

DATA BASE DEFINITION

- UNIQUE NUMBER
- PERMIT NUMBER
- INSTALLATION CODE
- PERMIT HOLDER, CURRENT
- USE CODE
- COUNTY NUMBER
- WATERSHED UNIT
- TOWNSHIP
- RANGE
- EAST RANGE
- SECTION
- QUARTER
- QUADRANGLE
- LOCATION CONFIDENCE LEVEL
- LATITUDE
- LONGITUDE
- LAND-SURFACE ELEVATION
- LAND-SURFACE-ELEVATION ACCURACY
- WELL STATUS
- WELL TYPE
- MULTI-SINGLE AQUIFER
- AQUIFER TEST
- WELL LOG TYPE
- WATER LEVEL FLAG
- YEAR CONSTRUCTED
- WELL DRILLER
- WELL DEPTH, LSD
- WELL DEPTH, MSL
- WELL DEPTH SOURCE
- MGSLOG

CASING
- CASING MATERIAL
- CASING DIAMETER
- CASED FROM MSL
- CASED TO MSL

OPENING
- OPENING TYPE
- OPENING MATERIAL
- OPENING DIAMETER
- SLOT-GAUGE
- OPENING TOP
- OPENING BOTTOM

PUMP
- PUMP TYPE
- POWER SOURCE
- PUMP CAPACITY
- HORSEPOWER
- LOWEST INTAKE LEVEL
- DATE INSTALLED

AQUIFER
- AQUIFER LITHOLOGY
- AQUIFER STRATIGRAPHIC UNIT
- OVERLYING MATERIAL
- AQUIFER TOP - MSL
- AQUIFER BOTTOM - MSL

CONFINING BED
- CONFINING BED LITHOLOGY
- CONFINING BED STRATIGRAPHIC UNIT
- CONFINING BED TOP - MSL
- CONFINING BED BOTTOM - MSL

DRILLER'S PRODUCTION TEST
- TEST DATE
- TEST LENGTH
- TEST STATIC LEVEL
- TEST PUMPING WATER LEVEL
- TEST PUMPING RATE

WATER LEVEL MEASUREMENT
- DATE MEASURED
- WATER LEVEL

COMMENTS