

MINNESOTA GEOLOGICAL SURVEY
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GROUND-WATER DATA MANAGEMENT

The COUNTY WELL INDEX

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Data contributors

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INTRODUCTION

The importance of ground water in Minnesota cannot be overemphasized. In rural Minnesota we rely almost completely on ground water to satisfy our water needs and nearly all municipalities outside of the Twin Cities metropolitan area use it for their public water supplies.

The past decade has been a time of dramatic increase in the public awareness of this reliance on ground water and of the impact our activities have on this important resource. We have come to realize that, like other natural resources, ground water is not infinitely available everywhere and that it is susceptible to contamination and depletion. Foresight and planning are needed if we are to use our ground water wisely and insure that we have adequate supplies of water – for drinking, for farming and industry, and for recreation – far into the future. Let it not be said of us that "they never missed the water 'til the well ran dry."

In general, the more we know about something, the better our chances of making wise decisions concerning its use. So it is with ground water. The first step in managing the use of ground water is to collect, in an organized manner, as much basic information about it as possible – how much is being used; where it is coming from; whether its current state is good, polluted, or somewhere in between; what its setting is, that is the geology of the "container" that holds the water; and what the chemistry of the water is. This report addresses the collection and management of ground-water data. It will discuss the major sources of data and some techniques for collecting and processing the data. It presents the County Well Index – computer software that is a tool for collecting the data "in an organized manner" and managing and exchanging these data.

GROUND-WATER DATA

Sources - Water-well records The largest and most readily available source of information on ground water and subsurface geology is water-well records. Prior to 1974, most drilling contractors kept their own records on wells that they had drilled. In 1974, legislation was enacted requiring that logs for all new water wells be submitted to the Minnesota Department of Health (MDH). A standardized reporting form was developed. Figure 1 shows the current version of the form.

The required information includes locational data – county, Public Land Survey description, and address, identification – the owner's name, use and construction information, and a log describing the geologic materials drilled through. Many well records include pumpage test results which are useful for determining the physical properties and potential yield of the aquifer being used.

level the number of new wells per year may be only a few tens or hundreds, depending on population growth and construction activity.

In addition to filing a well log, well drillers are also required to have the water from new wells tested for coliform bacteria contamination and nitrate nitrogen level. These data are filed with the MDH and provide an important second dimension to the understanding of the ground-water condition (the well log providing the physical dimension), namely the quality or water chemistry dimension.

Other Sources

Other sources of ground-water information fall into two general categories: (1) data describing the geologic "container" for the water, and (2) data describing the water itself. Included in the first category are downhole geophysical logs, downhole television scans, engineering test borings, and seismic profiles.

Geophysical logs are made by lowering instruments down the well or drill hole and measuring the physical properties of the geologic materials through which the hole passes. They provide enough information to create a log of geologic formations for wells without an original driller's log. In fact, these data permit a more accurate geologic interpretation than is possible if only the driller's log is available and are used as control points for interpreting logs of other wells. Some well construction information, notably the diameter of the hole and the depth of the casing, can also be determined.

Geophysical logs are acquired by a number of private exploration companies. The MGS also logs a few holes each year at the request of the MDH when public health issues are involved. The MGS maintains a computerized index of geophysical logs and a file of many of the logs themselves.

Downhole television scans do not aid geologic interpretation, but are useful for checking the well construction. Downhole scans are done both by the private sector and by the MDH. To our knowledge, there is no systematic record of the scans acquired by the private sector, but MDH scans are part of the public record.

Engineering test borings yield high-quality data on the near-surface geology. These borings are typically done to assess the physical properties, such as strength, compactibility, permeability, and moisture content, of the geologic materials at bridge or construction sites. These data are limited both in distribution (they tend to be concentrated along roadways and in metropolitan areas) and in depth (generally from 10 to 20 feet or to the top of the bedrock).

Seismic profiles are done to augment other data in specific areas where the geologic setting is unusually interesting or difficult to interpret and there are not enough drill hole data to resolve the problem. Most of these profiles have been incorporated into published geologic maps, and it is usually not necessary to refer back to the original data, although they may be available from the DNR or MGS.

Data describing the water itself are available from a number of sources, both locally and from state agencies. Basic water-quality data, meaning coliform bacteria and nitrate data, are commonly available at the county level, usually at the public health or planning and zoning offices. Some counties have extensive sampling programs that test for a large number of water chemistry and quality parameters. At the state level, data are available for quality, quantity, and uses of ground water. A very useful discussion of these data, titled "Using Ground-Water Data for Water Planning," was prepared by representatives from several agencies in 1987 with the support of the Legislative Commission on Minnesota Resources (LCMR); copies of this booklet can be obtained from the MGS. Since then, two projects to make these data more accessible have been undertaken. One is the CWI which is described here. It provides a means to make data collected at the state level available locally, and is a tool to collect and manipulate data from well records and chemical analyses at the local level. The other is GWATER (Ground-Water Clearing House Data Base), which is being developed by the Land Management Information Center (LMIC) of the State Planning Agency. The purpose of GWATER is to pull together information from many sources, including CWI, and make it available as a centralized data base accessed via telephone.

Data Correlation

Collecting all the available geological and hydrological data for an area from all the various sources is the first step in understanding the local ground-water environment. The second step, in practice often done concurrently with the first, is the correlation of the data. We may have nitrate data from the county health office, well-log data from CWI, water-level measurements from the DNR, and water-chemistry data from the Pollution Control Agency (PCA). Linking together all the information for a specific well makes the data much more useful than they are separately. Data correlation is difficult and time-consuming. There is no easy way to do this, but a suggested method is outlined below.

Unique Numbers

A critical element in correlating the data and in referencing water-well data is the "unique number." This is a number assigned to each water well or drill hole. Once assigned to a well, the number is never used again; it is "unique" to that particular well and may be used to relate all other data for that well to the well log. If the unique number is recorded as water samples are collected, water levels are measured, chemical analyses are reported, or other data are collected from a well, it is a trivial matter to pull all the data together. The difficult task is determining the unique number for the many pieces of diverse data collected over the years.

The first step in correlating data is to determine whether there already is unique number for the well under consideration. This is done by first checking CWI or the state well index WELLS available through LMIC or DNR Division of Waters. It is necessary to look at other pieces of the data to search for a match – the name, the address,

the township-range-section, the depth of the well, perhaps the depth of the casing, or some combination of these. Some of the well records in CWI have local identifiers such as property/parcel or emergency services numbers. These may also help in matching data. If no well record, hence no unique number, can be found, it is necessary to assign a unique number to the well.

Unique numbers are now automatically assigned when the driller fills out the MDH Water Well Record on which the number is pre-printed (Fig.1). Wells drilled prior to the development of the MDH reporting form in 1974 were not originally assigned numbers. These records, originally kept in drillers' files and assorted county and state agency collections, are loosely referred to as the "historic logs." In the 1970s, the MGS copied many of these logs and assigned unique numbers to them; they now form part of the CWI.

Two groups of wells still lack unique numbers. By far the larger consists of those wells for which no log exists – either a log was never made or it has since been lost or destroyed. The 190,000 wells for which logs *do* exist represents a small percentage of the total number of wells actually drilled. The second group of wells lacking unique numbers are those with "historic logs" that were not collected by the MGS, but still exist in drillers' files or various county records.

Assigning Unique Numbers

If a log, meaning a description of the geologic materials the well passes through, exists for a well and no record of the well can be found in CWI or WELLS, the well may be assigned a new unique number. The MGS coordinates the assignment of unique numbers to older well logs (the MDH is responsible for unique numbers on new wells) so that numbers are used only once. This is very important because a number assigned to more than one well is no longer "unique" and we lose our correlation tag. After a number is obtained from the MGS it is written on the log and is then the permanent identifier for that well. A copy of the log with its new number should be forwarded to the MGS so that CWI and the state well index can be updated. This will ensure that anyone else looking through CWI or WELLS for that particular well will be able to find it and refer to it by its assigned number and not assign it another number.

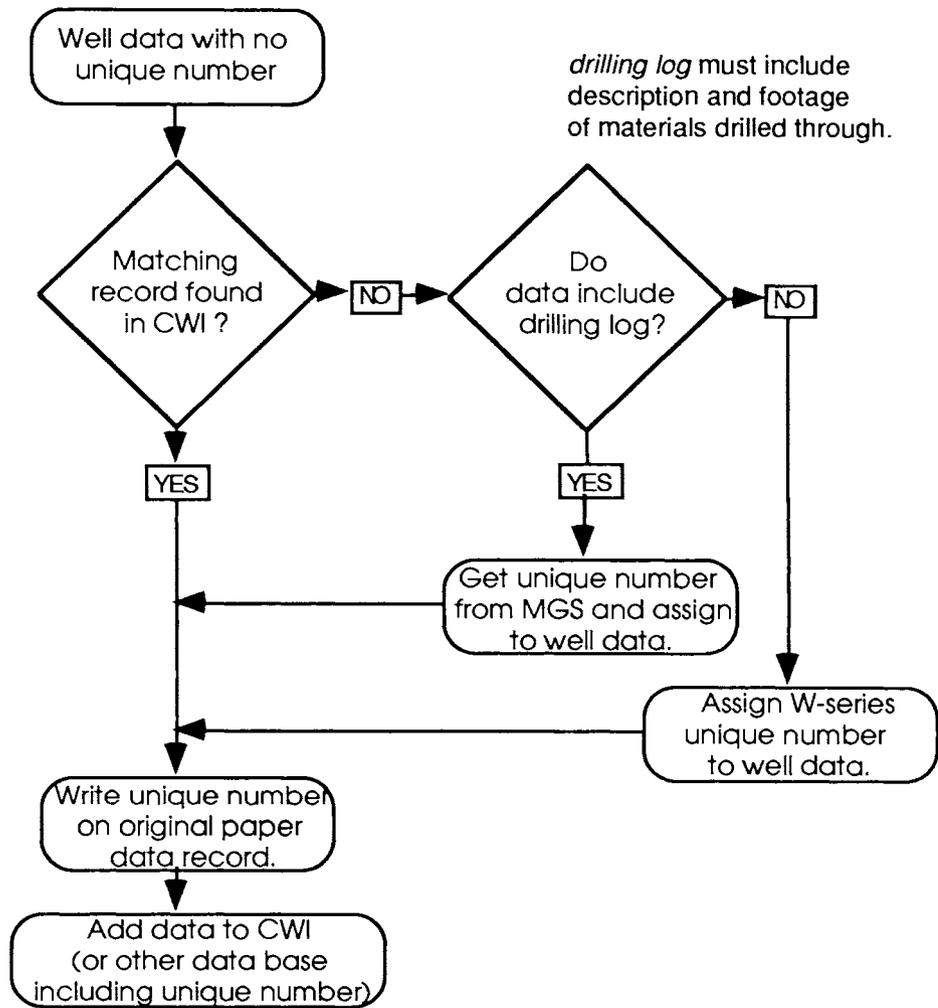
W-Series Unique Numbers

If *no* log exists for a well, it is *not* assigned a standard 6-digit unique number. Instead, it is assigned what is referred to as a "W-series" number, consisting of a "W" plus a 5-digit number (for example: W05132) plus the 2-digit county code (Appendix C.1). MGS also coordinates assignment of W-series numbers to minimize the possibility of numbers being assigned more than once, or two different W-series numbers being assigned to the same well. Upon request, the MGS will provide to county staff, well drillers, agency staff, or others involved in county ground-water data collection, a list of W-series numbers that may be assigned to wells.

Once a well has a unique number, all new data and references to that well should include that number so that the information can be related back to the well log or other data collected and correlated earlier.

The flow chart (Fig. 2) shows the correlation procedure in a graphical form.

Figure 2 Data correlation flow chart



A procedure that is useful for correlating ground-water data on a county-wide basis is to add the property identification numbers as the "local identifier" to existing well logs on CWI. The property identification number can be required as part of new data recorded; it is usually available from home owners or by name and address from county tax records. With the property identification numbers linked to the well logs in CWI it is very easy to pull the data together for each well or to determine that no record exists in CWI for a well on a given property.

Locating Wells - The Geographic Component

Without an accurate location, a well record and the associated quality and condition data we have worked so hard to correlate are of little value. It is not possible to describe or map the geology and ground-water conditions of an area unless the data are located geographically. Furthermore, the accuracy of the "picture" or interpretation of the ground-water conditions and environment relies directly upon the accuracy of the locations of the data.

Well records should, and most do, provide some locational information in the form of the address, the Public Land Survey (PLS) township-range-section, and sometimes a description or sketch map of the location relative to nearby landmarks or its approximate position in the section. This information is very helpful in establishing the more precise locations needed for geologic mapping and description of the ground-water conditions. Mapping and interpretation are done from data points on maps and not from addresses or PLS descriptions.

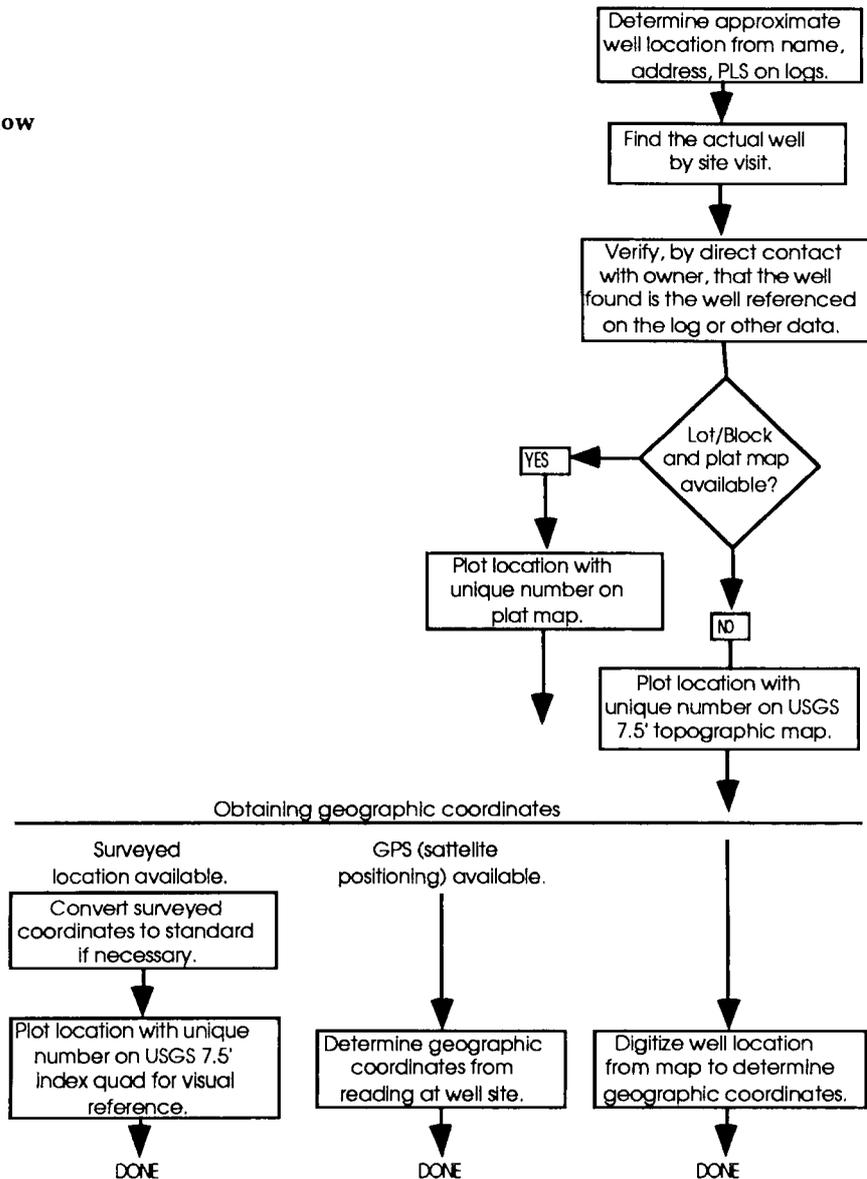
"Locating wells" is the process of converting descriptive locational information on well records or other data to accurately placed points on maps. The end results of locating data are (1) the locations of the wells plotted, along with their unique numbers as labels, on USGS 7.5-minute (1:24,000) topographic maps or the more detailed large-scale plat maps used in property developments, and (2) determination of geographic coordinates – either latitude/longitude to .001 seconds or projection coordinates (State Plane, UTM, or other coordinates that can be converted to latitude/longitude). The geographic coordinates are used to plot ground-water data using computers.

Before the well locations are plotted on the maps, they should be field verified. This involves the following steps: (1) determine the approximate location from any locational information provided with the data – name, address, PLS; (2) with topographic map in hand, find the actual well; (3) verify that the well found is the well referenced in the log or data by asking the owner or a neighbor, if possible, about the well's construction date, the depth, the driller, the well use, and the owner's name and address. While still at the well site one would plot the actual location of the well on the topographic quadrangle map, and, if a GPS (Global Positioning System) receiver is being used, take a reading of the geographic coordinates.

Geographic coordinates, for wells whose coordinates are not determined by surveying or using GPS, can be determined by digitizing the points plotted on the topographic maps. Though not absolutely essential, these coordinates, when properly converted, can be used for plotting the data by computer. The plotting of different data elements – the elevation of the bedrock surface or the water table, for example – is necessary to interpret the geologic and hydrologic conditions. Computer plotting can save considerable time in accomplishing this rather monotonous task.

Figure 3 shows graphically the process used for locating data described above.

Figure 3. Data location flow chart

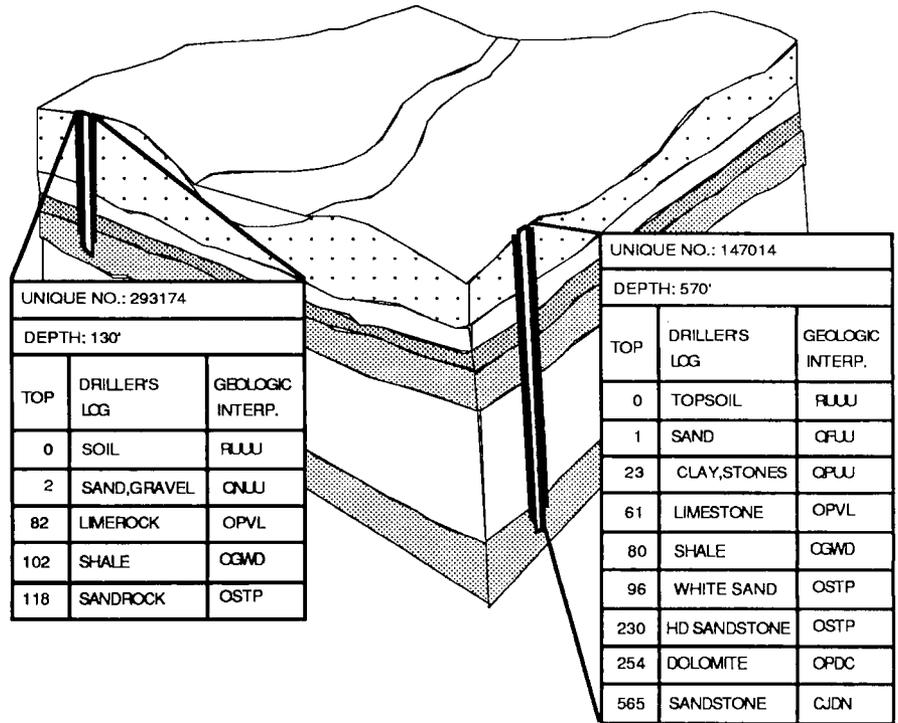


Geologic Interpretation

Once collected, correlated, and located, the data can be put to use in developing the geologic and hydrogeologic framework of the ground-water conditions of the area. Each reporting form submitted by a drilling contractor contains a log of the materials intersected and how far down in the hole they are. These descriptions are "interpreted," or translated into the formal names of geologic formations. These names tell us more than just what general kind of rock is encountered in the hole. They tell us which specific rock unit is there and relate it to

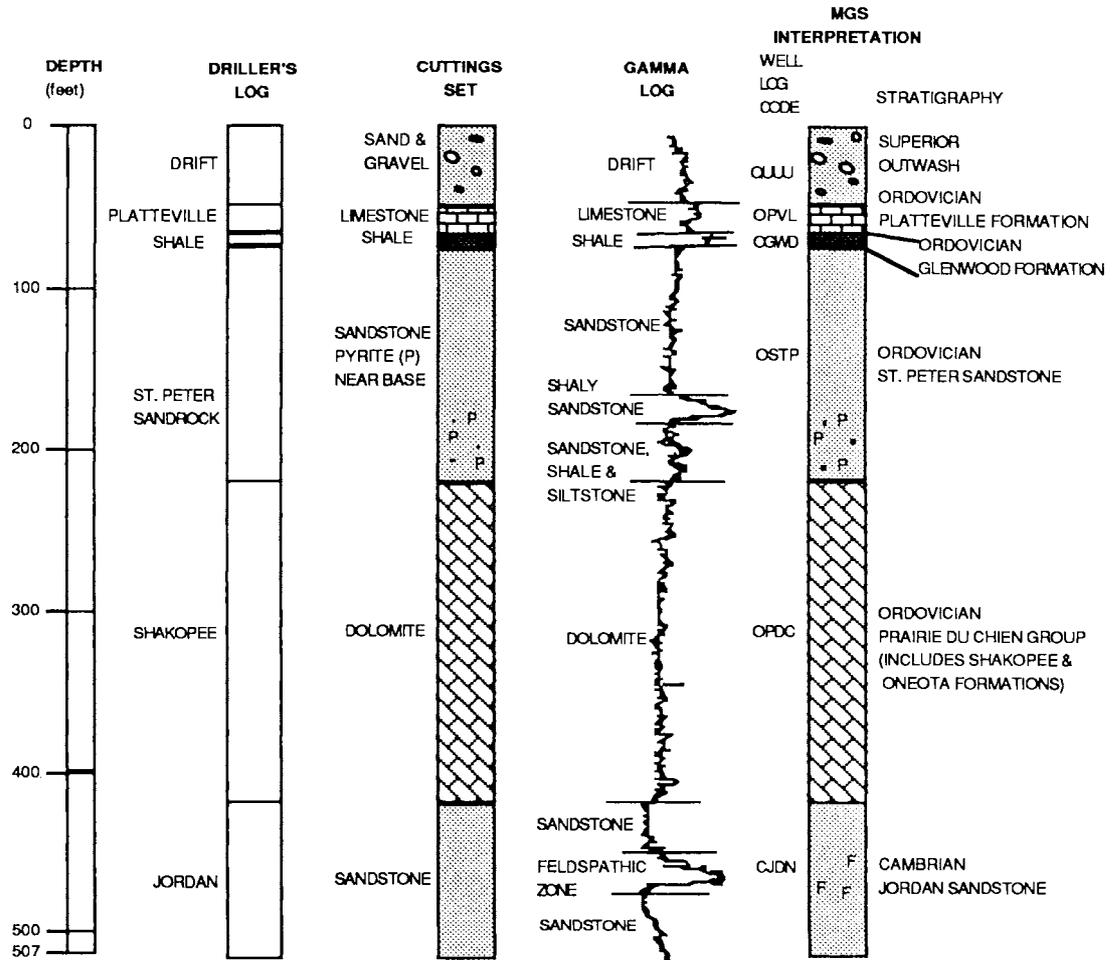
the same formation in other drill holes. For example, we know that the sandstone at a particular depth in a well is the Jordan Sandstone and not the St. Peter or Hinckley and that it is continuous with the Jordan Sandstone at a slightly different depth in a well 3 miles or 30 miles away. Figure 4 shows in a schematic sense how the interpreted logs relate to the geology of an area.

Figure 4 Interpretation of well logs and the geologic setting



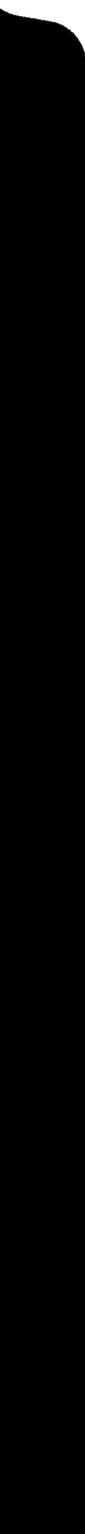
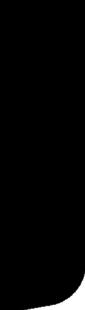
Making a geologic interpretation of a driller's well log is not a simple process. It requires a trained geologist's judgment and experience and information from surrounding wells, cuttings samples or core, down-hole geophysical logs, and outcrops or other field evidence. The interpretation for one well must make geologic sense with the interpretations for the surrounding wells and with the outcrops. Cuttings, core, and geophysical logs are available for very few holes, but they provide the control, or points of greater certainty, upon which the interpretations of the records of surrounding wells are based.

Figure 5 Data sources and geologic interpretation (based on a graphic by Jane Cleland, MGS)



After the geology has been interpreted, it is possible to use the well construction information (primarily the depth of the deepest casing) to determine which aquifer supplies the water in a given well. The water level measurements and pump test data can be used to characterize the aquifer and determine the direction of ground-water movement. With this information in hand we can then begin to say something about the nature of contamination should it be detected in the well or surrounding wells – whether or not it is caused by improper construction and limited to a specific well or whether a larger scale aquifer contamination problem exists.

It is not until we have reached this point – after the data have been collected, correlated, located, and interpreted – that we can fully utilize the data to produce geologic and hydrogeologic maps and derivative maps such as ground-water sensitivity maps, and address the problems of ground-water use, protection, and planning.



The COUNTY WELL INDEX

Overview

The County Well Index (CWI) is a PC-based, computerized data base system developed by the Minnesota Geological Survey (MGS) to provide a means for storage and retrieval of basic water well information. In 1989 the LCMR provided funding for expanding CWI to handle well log, well construction, and water chemistry data in addition to the basic indexing of well logs and to publish documentation describing its use in collecting and managing ground-water data. The data previously contained in WELLOG, the MGS Water Well Data Base, are now included as part of CWI. CWI is intended to provide a fast, easy, low-cost tool for collecting and managing information for use in addressing geologic, ground-water, and state and local water-planning issues.

The requirement that the data be made available via inexpensive, widely compatible microcomputers utilizing standard software for access by individuals or local governmental units, as well as via mainframe or minicomputer for large-volume retrievals, was an important consideration in the design and development of the system. It is hoped that data capture (input) and utilization (output) can be effected at local levels with coordination, correlation, interpretation, and additional information provided by the MGS and other agencies at the state level.

As of May 1991, CWI contained data for some 135,000 water wells from throughout Minnesota. The bulk of the information is obtained from well records submitted by well drillers as mandated by the Minnesota Water Well Construction Code of 1974. Additional historic data have been collected by the MGS from drillers' files, county health offices, and state and federal agencies' files. Approximately 10,000 to 14,000 well records are received each year by the Survey from drillers filing logs in compliance with the 1974 Code. The MGS hopes that with the necessary funding and the cooperation of users of the information, the new data can be added on a timely basis and the usefulness of the data base enhanced and maintained.

It should be noted that the data included in the CWI vary in quality depending upon a number of factors. The 40,000+ entries that have been field located and have geologic interpretations of the driller's log represent the highest quality data. The remaining data reflect the locations and other information as recorded by the drillers or other primary data sources. As such, these data range from very good to better-than-nothing. The limitations of the data should be kept in mind when drawing conclusions based upon them.

The data files for the CWI have been organized by county. Because of the large amount of data available for some counties, the data may be further divided by townships, blocks of townships, or in some cases, blocks of sections within a township.

Compatibility and system requirements

CWI requires an IBM PC/XT/AT, PS/2 or compatible computer with at least 512K bytes of memory (RAM), MS-DOS/PC-DOS 2.10 or higher, one 5.25" or 3.5" floppy, and a hard disk. Printed output is intended for an Epson- or IBM-compatible printer, but most others should yield reasonably satisfactory results. It is also possible to direct output to a file and process it to a printer later using standard word-processing software. Special arrangements can be made to provide CWI in a floppy version for those without a hard disk, but the hard disk version is strongly recommended.

Although the MGS puts a great deal of effort into assuring that these programs and the information distributed are as accurate as possible, it provides the software and data "as is." The MGS does not warrant or guarantee the accuracy of the data or the performance of the software and assumes no liability for their use. As always, however, MGS staff is happy to answer questions or offer technical or scientific advice whenever possible. It should also be noted that geologic interpretations are based on the information available at the time of interpretation. The interpretations are subject to revision at any time as more information becomes available.

Getting started

This "how-to" section assumes that you have some basic familiarity with the computer you will be using. Please refer to the materials received with your computer for additional information as needed, such as what the **A: DRIVE** is and the basic operating procedures. Note also that the instructions given below assume that your computer is running from the DOS environment rather than a "shell" program. If you see the DOS prompt **A>**, **B>**, or **C>** or something close, such as **C:\>**, then you are in the DOS environment.

Before using CWI, it is wise to make backup copies of the program and data diskettes (unless you intend to run CWI from a hard disk). There are several ways to do this, but it is perhaps easiest to use the **DISKCOPY** command. Check with your systems documentation if you are unsure of how to make copies.

Installing CWI

The CWI program and data files are distributed in a compressed format using a program called PKZIP created by PKWARE, Inc. of Glendale, Wisconsin. To install CWI and data files on your hard disk:

- 1) insert the CWI distribution into the appropriate floppy drive;
- 2) switch to that drive by typing **A:** or **B:** followed by *return*;
- 3) install CWI by typing **INSTALL x:** followed by *return*, where **x** is the letter for the hard drive on which you wish to install CWI (most often **C** but could be **D**, **E**, **F**, etc.).

At this point the files on the CWI distribution disk will be expanded onto a directory called "CWI" on the hard disk specified in step 3

above. If you have more than one CWI distribution disk, repeat the process outlined above for each disk. It is important that you have enough free space available on your hard drive. Some of the CWI data files will take several megabytes. If you have difficulty with the installation process, refer to the section below, "Problems and CWI Support."

Running CWI

To execute the CWI program from a hard disk simply:

- 1) switch to the CWI directory by typing `CD\CWI` *return*;
- 2) start CWI by typing `CWI` *return*;
- 3) CWI will ask for the drive on which the data files are located. Enter *return* since they are on the current drive.
- 4) The next prompt will be for a "data base identifier." The data base identifier is a two- or three-character code identifying the data file of interest. The first two characters usually specify the county code (Appendix C.1) and the third, if present, the sub-area within the county.

At this point CWI is ready for commands. `HELP` will result in a list of available commands. These commands and their uses are described below. A typical CWI initialization session would look like this:

<p><i>The "return" or "enter" key is pressed to indicate that the data files are on the current drive.</i></p> <p><i>The data base id 56 is entered selecting the data for Otter Tail County.</i></p>	<pre> ** COUNTY WELL INDEX [CWI]. VERSION 3.0 ** MINNESOTA GEOLOGICAL SURVEY. 1991. **BEGINNING CWI DATA BASE INITIALIZATION ** ** LOADING CODE DEFINITIONS, PLEASE BE PATIENT... * PLEASE ENTER LETTER OF DRIVE ON WHICH * THE CWI DATA FILE(S) ARE (TO BE) LOCATED. * (HIT RETURN IF ON CURRENT DRIVE) * DRIVE LETTER FOR CWI DATA FILES : * ENTER DATA BASE ID : 56 DATA BASE TITLE : OTTER TAIL CO. CURRENT NUMBER OF RECORDS : 3726 ** INITIALIZATION COMPLETE ** >PLEASE ENTER A COMMAND (LEVEL 0) : >("HELP" FOR LIST OF COMMANDS) : HELP </pre>
---	---

Running CWI from a two-floppy PC - Although it is recommended that CWI be run on a PC with a hard disk, it is possible to run it on a computer with two floppy drives and no hard drive. If you wish to run CWI in this fashion please contact the MGS at the number or address listed below in the section "CWI Support."

Using CWI

After initialization, the CWI program is at the MAIN command level (level 0). The CWI program has two levels of commands. The main command level (level 0) provides for selecting all or a subset of the data base file based on specification of a number of parameters, sorting the selected working data base, and listing or generating reports to the screen, to a printer, or to a file for later processing. The other command level (level 1) allows selection of a specific well record based on unique number, local identifier or permit number, name or address, listing or report generation for that record, access to the data editing and data addition capabilities, and direct entry of new records.

Structure of CWI

Before using CWI, it is a good idea to know something of the underlying organization of the data base. CWI is made up of three major parts – the index portion (CWI), the well log and well construction portion (CWI/WL), and the water chemistry portion (CWI/WC). There will always be data in the CWI section for any well included in the data base because it contains primary information regarding the well such as location, name, depth, and use. There may or may not be entries for a well in the CWI/WL or CWI/WC sections of the data base depending upon the availability of data and resources for entering the data into the system. A file containing Zone 15 Universal Transverse Mercator (UTM) projection coordinates may also be associated with the CWI data files. These coordinates make it possible to plot the data on a map using EPPL7 or some other computer mapping package or GIS. The UTM file is not required for CWI to function.

Level 0 commands

The commands available at the main level are displayed on the screen in response to the entry of "Help" when prompted for a level 0 command:

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : HELP

>LEVEL 0 COMMANDS :
-----
SELECT      : SELECT WORKING DATA BASE.
SUBSELECT   : SELECT SUBSET OF WORKING DATA BASE.
ACCESS      : SET ACCESS (CWI, CWI/WL, CWI/WC).
SET OUTPUT  : SET OUTPUT DESTINATION.
LIST        : LIST WORKING DATA BASE INDEX.
REPORT      : GENERATE REPORTS FOR WORKING DATA BASE.
SORT        : SORT WORKING DATA BASE.
SELECT REC  : SELECT/UPDATE/CREATE A DATA BASE RECORD.
UNLOAD      : UNLOAD DATA FROM WORKING DATA BASE.
END         : TERMINATE SESSION.
```

Level 1 commands

Level 1 commands are available upon execution of the **SELECT REC** command from level 0. "Help" in response to the level 1 prompt will produce a list of the level 1 commands. Note that four commands, **ACCESS**, **SET OUTPUT**, **LIST**, and **REPORT** are available at both command levels. When used from level 1, **LIST** and **REPORT** generate output for a selected record only. When used from level 0, they generate output for the entire working data base.

The SELECT REC command accesses level 1.

HELP provides a listing of the level 1 commands.

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SELECT REC

>>ENTERING LEVEL 1.

>>PLEASE ENTER COMMAND (LEVEL 1):
>>("HELP" FOR LIST OF COMMANDS) : HELP

>>LEVEL 1 COMMANDS :
-----
UN.NO.      : SELECT RECORD BY MINN. UNIQUE NUMBER..
ID.DO.      : SELECT RECORD BY LOCAL ID NUMBER.
PERMIT NO.  : SELECT RECORD BY PERMIT NUMBER.
NAME        : SELECT RECORD BY NAME.
ADDRESS     : SELECT RECORD BY ADDRESS.
NEXT        : SELECT NEXT RECORD.
PREVIOUS    : SELECT PREVIOUS RECORD.
ACCESS      : SET ACCESS (CWI, CWI/WL, CWI/WC).
SET OUTPUT  : SET OUTPUT DESTINATION.
LIST        : LIST SELECTED RECORD INDEX.
REPORT      : GENERATE REPORT FOR SELECTED RECORD.
UPDATE      : MODIFY SELECTED RECORD.
CREATE      : CREATE NEW RECORD[S].
END         : RETURN TO MAIN LEVEL (LEVEL 0).
```

The use of these and the level 0 commands are discussed in the following section.

Retrievals

CWI allows you to select water-well data based on many criteria. When the program is begun, the entire data base is the working data base. The **SELECT** command permits selection of a portion of that data base to be a current or "working" data base. The criteria for establishing the working data base are set by specifying one or a combination of the parameters listed on the following page.

The selection criteria fields may be specified by entering either the field name as given or the number listed next to the name. Some of the fields are not used as **SELECT** parameters. Name, address, local identifier, and permit number are used as level 1 search criteria via the **SELECT REC** command. This is because **SELECT REC** is used to search for data for one specific well whereas **SELECT** is used to select data for all wells satisfying specified criteria. Note that some of the selection criteria searches are not implemented at this time; they are included as future options.

HELP provides a list of selection criteria available.

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SELECT

>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" TO RESET TO ENTIRE DATA BASE;):
>("DONE" WHEN DONE SETTING CRITERIA ) : HELP

1 UN.NO.          17 FIRST BDRK      33 COR/CUT/GP
2 COUNTY          18 DATE DRLD       34 PUMP TEST
3 TOWNSHIP        19 DRLLR/DS        35 CAPACITY
4 RANGE           20 NAME            36 SAMP.D.B.
5 SECTION         21 ADDRESS         37 SAMP.D.E.
6 SUBSECTION      22 LOCAL ID.       38 WC-BASIC
7 ELEVATION       23 PERMIT NO.      39 WC-MICRO
8 QUAD CODE       24 WHPA CODE       40 WC-INORG
9 USE             25 USER DEF.1     41 WC-VOC
10 STATUS         26 USER DEF.2     42 WC-NON-VOC
11 DEPTH          27 NITRATE         43 WC-MCL
12 CSNG DIAM.    28 NO3 DATE        44 WC-RAL
13 AQUIFER        29 BACTERIA        45 ENTRY DATE
14 O.H.TOP        30 BACT.DATE       46 UPDATED
15 O.H.BTTM      31 SWL ELEV
16 DEPTH BDRK    32 SWL DATE

```

The following list indicates what is meant by the abbreviated field names used for specifying selection criteria. Appendix B further clarifies the meanings and codes used for the various fields.

SELECT parameter descriptions

UN.NO.	- specify list of unique numbers
COUNTY	- select by county code
TOWNSHIP	- specify township(s), range(s), section(s)
RANGE	- same, also SECTION & SUBSECTION
ELEVATION	- specify range for surface elevation
QUAD CODE	- specify MSG quadrangle codes
USE	- specification of use codes
STATUS	- select by well status (active/inactive)
DEPTH	- specify min./max. well depth
CSNG DIAM.	- select by range of minimum casing diameter
AQUIFER	- specify aquifer codes
O.H.TOP	- specify stratigraphic codes for geologic unit at the top of open hole interval
O.H.BTTM	- specify stratigraphic codes for geologic unit at the bottom of open hole interval
DEPTH BDRK	- specify depth-to-bedrock range
FIRST BDRK	- specify stratigraphics codes of top bedrock unit
DATE DRLD	- specify drilling date range
DRLLR/DS	- select by driller or data source code
WHPA CODE	- select by Well-Head Protection Area code(s)
USER DEF.1	- specify User Defined code
USER DEF.2	- specify range for User Defined value
NITRATE	- specify nitrate value range
NO3 DATE	- specify range of dates of nitrate analyses
BACTERIA	- specification of bacteria count range
BACT DATE	- specify range of dates of bacteria samples
SWL ELEV	- specify static water level elevation range

- SWL DATE - specify swl measurement date range
- COR/CUT/GP - select records for wells for which core, cuttings, or geophysical logs are available
- PUMP TEST - select records including pumpage test data
- CAPACITY - specify range for pump capacity
- WC-BASIC - select records with data for at least 1 "basic" water chemistry parameter (see Appendix C.4 for water chemistry groupings).
- WC-MICRO - select records with microbiological data
- WC-INORG - select records with data for at least 1 inorganic water chemistry parameter
- WC-VOC - select records with data for at least 1 volatile organic compound
- WC-NON-VOC - select records with data for at least 1 non-volatile organic parameter
- WC-MCL - select records for which the MCL (maximum contaminant level - EPA Safe Drinking Water Act) is exceeded for at least 1 parameter.
- WC-RAL - select records for which the RAL (Recommended Allowable Limits for drinking water contaminants as established by the MDH) is exceeded for at least 1 parameter.
- ENTRY DATE - specify range of dates data records were entered
- UPDATED - specify range of dates data records were last updated

An example of a **SELECTION** might be to set township, range, and section criteria, a specific aquifer code (see Appendix C.2), and a nitrate level ranging from 10 to 100 to examine the contamination problem within a given aquifer for a specific area. CWI would then select those wells in the active data base files satisfying those conditions. The section "CWI Applications – Examples" below demonstrates the use of **SELECT** and some of the other commands.

Once a working data base has been established, it can be reordered by **SORTING** by township, range, and section, or unique number (UN.NO.), or by most of the selection parameters listed above.

The working data base may be examined on the screen using the **LIST** command to generate an abbreviated one-line-per-well listing or the **REPORT** command which generates formatted reports for each well record. Figures 6 and 7 show samples of the output from the **LIST** and **REPORT** commands respectively.

Figure 6 Sample LIST output to screen

UN.NO.	CO	T-R-S	USE	DP	TH	AQU	NO3	BACT	SWEL	WL	WC	NAME
104106	82	27-21-12CBCD	DO	170	OPDC				850	Y		BILL K
104297	82	27-21-12CBDD	DO	140	CJDN				851	Y		O.T. M
104238	82	27-21-12CBDC	DO	220	CJDN			NEG	843	Y		BILL K
104207	82	27-21-13ADAD	DO	200	CJDN				830	Y		RICHAR
106287	82	27-21-13CBBB	DO	180	OPDC		<.1		825	Y		LEN BO

Figure 7 Sample REPORT output

```

*****
MINNESOTA COUNTY WELL INDEX.
UN.NO./CO. : 999992/25                ENTERED: 1991/06/23
NAME       : BUMSTEAD, DAGWOOD         UPDATED: 1991/06/23

COUNTY   : GOODHUE                   USE    : DOMESTIC   DRILLED: 1988/10/20
T/R/SEC.  : 109/15/ 8CBBACD           DEPTH  : 420 FT.   DEPTH D: 420 FT.
ELEVATION : 1128 FT.(TOPO )           CASED  : 404 FT.   GROUT  : YES
DIAM.     : 4 IN.                     DRL/DS : 19521    :KIMMES-BAUER
LOC.METH. : INFO.OWNER                LOC.BY : MGS      COORDS.:
STATUS    : ACTIVE                    WHPA   :             DNR PA#:
USER 1    : GQ702                     USER 2 :

DPTH BDRK: 45 FT.                     BEDROCK: ST.PETER
OPEN HOLE: PRAIRIE DU CHIEN GROUP
AQUIFER  : PRAIRIE DU CHIEN GROUP

ADDRESS   : RR2 BOX 173 , ZUMBROTA , MN 55992
QUAD(7.5): ZUMBROTA                   CONTACT:
POTENTIAL POLLUTION SOURCE: 75 FT.   DIR.: S   TYPE: SEPTIC/DFL
CWI/WL: YES  CWI/WC: NO  CORE/CTNGS/GP.: CUTTINGS
IGWIS : SWUDS : OBWELL: YES

      DATE      NITRATE  BACTERIA  SOURCE      SWL  ELEV  SOURCE
-----
1989/06/23
1988/11/13  <0.1      NEG     MDH          167  961  USGS
1988/10/20
                                160  968  19521

COMMENTS: 0.5 MILES EAST OF US 52.
          GAMMA LOGGED; MGS; 1989/06/23.
*****
    
```

The output from the LIST or REPORT command may be directed, using the SET OUTPUT command, to a printer, the screen, or both, or to a file for later printing or processing. Note that LIST generates slightly more output when it is directed to the printer or a file than when it is directed to the screen. This is because the line length on the computer monitor is limited.

Figure 8 LIST output to printer

UN.NO.	CO	T-R-S	QUAD	ELEV	USE	DPTH	AQU	D2BR	FBRK	LUNT	NO3	DATE	BACT	DATE	SWEL	DATE	WL	WC	NAME
999992	25	109-15-	8CBBA	69C	1128	DO	420	OPDC	45	OSTP	OPDC	0.1	198811	NEG	198811	961	198906	Y	BUMSTE

ACCESS is used to specify for which part(s) of the data base – CWI, CWI/WL, and/or CWI/WC – output is generated when the REPORT command is executed. The ACCESS options are:

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : ACCESS

>SELECT AN UNLOAD OPTION :
>(ENTER "HELP" FOR OPTIONS):
>ACCESS OPTION? : HELP

THE ACCESS OPTIONS ARE :
1 - CWI.
2 - CWI + CWI/WL.
3 - CWI + CWI/WC.
4 - CWI + CWI/WL + CWI/WC.
5 - CWI/WL.
6 - CWI/WC.
    
```

Figures 9 and 10 are samples of the reports generated for the CWI/WL and CWI/WC portions of the data, respectively.

Figure 9 Sample REPORT for CWI/WL

```

*****
MINNESOTA COUNTY WELL INDEX/WELL LOG.
UN.NO./CO. : 999992/25          NAME : BUMSTEAD, DAGWOOD

COUNTY : GOODHUE              QUAD : ZUMBROTA
T/R/SEC. : 109/15/ 8CBBACD     ELEV : 1128 FT.      DEPTH D: 420 FT.
BDRK ELEV: 1083 FT.           BEDROCK: ST.PETER
OPEN INT.: PRAIRIE DU CHIEN GROUP
AQUIFER : PRAIRIE DU CHIEN GROUP
GEO.INTRP: MGS                 GEOLGST: BB      METHOD : CUTTINGS+GEOPHYS.
-----
WELL CONSTRUCTION.
DRILLER S NAME: WOODLEY, H.     DRV.SH.: YES
DRILLING METHOD: NON-SP.ROT.     FLUID : BENTONITE
CASNG MATERIAL: STEEL           JOINTNG: WELDED      TOP: 1 FT.
                                [GROUT-----]
                                DIAM (IN) FROM (FT) TO (FT) MATERIAL AMNT UNITS
-----
CASING 1 : 8 0 60
CASING 2 : 4 0 404
DRILL HOLE1: 12 60
DRILL HOLE2: 8 404
DRILL HOLE3: 4 420
GROUT 1 : 0 404 NEAT CMNT 14 YARDS
PITLESS ADAPTER. MAKE: WHITEWATER MODEL: SU4X5
BASEMENT OFFSET?: >/=12" ABOVE GRND: YES CASING PROTECT:
-----
SCREEN.
PRESENT?: NO OPEN HOLE FROM: 404 FT. TO: 420FT.
-----
PUMP.
INSTLLD?: YES DATE : 1988/11/21
MAKE : GOULDS MODEL: 10EJ07412
SIZE : 0.75 H.P. VOLTS: 230 CAPACITY: 10 GPM
TYPE : SUBMERSIBLE DROP PIPE: 170 FT. MATERIAL: GALVANIZED
-----
PUMPAGE TEST(S).
STATIC WATER LEVEL: 160 FT. DATE: 1988/10/20
LEVEL (FT) HOURS GPM DRAWDOWN (FT)
-----
TEST 1: 180 2 30 20.0
-----
DRILLER S/GEOLOGIC LOG
-----
DEPTH
INTERVAL DRILLER S DESCRIPTION COLOR HARDNESS
(IN FEET) [INTERPRETED LITHOLOGY] [STRATIGRAPHIC UNIT(S)] [AGE]
-----
0 45 CLAY YELLOW SOFT
[CLAY] [PLEISTOCENE DEPOSIT] [ ]
45 120 SAND ROCK BROWN SOFT
[SANDSTONE] [ST.PETER] [ORD]
120 240 SAND ROCK WHITE SOFT
[SANDSTONE] [ST.PETER] [ORD]
240 380 LIME YELLOW HARD
[DOLOMITE] [PRAIRIE DU CHIEN GROUP] [ORD]
380 400 SAND ROCK BROWN SOFT
[DOLOMITE, SANDSTONE, SHALE] [PRAIRIE DU CHIEN GROUP] [ORD]
400 420 SAND ROCK BLUE MEDIUM
[DOLOMITE, SANDSTONE] [PRAIRIE DU CHIEN GROUP] [ORD]
-----
*****
    
```

Figure 10 Sample REPORT for CWI/WC

```

*****
MINNESOTA COUNTY WELL INDEX/WATER CHEMISTRY.
UN.NO./CO. : 999992/25                                UPDATED: 1991/06/24

NAME       : BUMSTEAD, DAGWOOD
COUNTY    : GOODHUE          QUAD   : ZUMBROTA
T/R/SEC.   : 109/15/ 8CBBACD  ELEV   : 1128 FT.  DEPTH D: 420 FT.
OPEN INT.  : PRAIRIE DU CHIEN GROUP
AQUIFER    : PRAIRIE DU CHIEN GROUP
-----
UN.NO./CO.: 999992/25          SAMPLE NO.: 1

SAMP.DATE: 1989/06/17        SAMPLED BY: MGS
SAMP.DPTH: 190                SAMP.PROG: WC3
SAMPLE ID: WC3-004A          LAB.REF.#: B890023
LAB.CODE  : MDH

SWL       : 162 FT.  TEMP (C): 10  PH: 7.7  COLOR:
DIS.OX(MG/L):          SP.COND.: 517 UMHOS/CM
ALKALINITY (TOT.AS CACO3):          MG/L

PARAMETER          VALUE  UNITS  Q*1  T*2  CODE
-----
BICARBONATE        295  MG/L   3      00440
CALCIUM-D           78  MG/L   3  G  00915
MAGNESIUM-D         27  MG/L   3      00925
POTASSIUM-D         4   MG/L   3      00935
CHLORIDE (AS CL)   1.8  MG/L   3  G  00940
BORON-D            <10  UG/L   3      01020
SULFATE (AS SO4) -D 43  MG/L   3  G  00946
FLUORIDE-D         .2  MG/L   3  C  00950
SILICA (AS SIO2) -D 17  MG/L   3      00955
CARBONATE ION CO3  <1  MG/L   3      00445
IRON-D             807  UG/L   3      01046
-----
*1 Q - QUALITY CODES          *2 T - ANALYT. TECHNIQUE CODES
-----
3-NORMAL RELIABILITY          G-TITRATION
-                               C-SPECTROPHOTOMETRY
-----
*****
    
```

The **UNLOAD** command is available to write the working data base data and/or unload index file to ASCII text files for manipulation by special-purpose programs or transfer to other data base systems. The formats of the files generated by the command are described in Appendix A. **UNLOAD** has several options which allow different portions of the data base to be unloaded. One of the options will write a data file that can be used with EPPL7. The last portion of the CWI Applications section describes this link. The **UNLOAD** options are:

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : UNLOAD

>SELECT AN UNLOAD OPTION :
>(ENTER "HELP" FOR OPTIONS):
>UNLOAD OPTION?          : HELP

THE UNLOAD OPTIONS ARE :
1 - INDEX.
2 - CWI ONLY.
3 - CWI/WL ONLY.
4 - CWI/WC ONLY.
5 - ALL DATA.
6 - INDEX & ALL DATA.
7 - EPPL PLOT DATA.

The format of the Unload index
file generated when option 1 or 6
is selected is described in
Appendix A.4 (page A.11)
    
```

The level 0 **END** command terminates the CWI session. If editing of the data base is done or new records are added, it is essential to use the **END** command. CWI updates internal counters and files when the **END** command is executed. Turning off the computer without **ENDING** will result in damaged or unusable data base files.

SELECT REC provides access to the level 1 commands. It is used to search for and select a specific well record based on the well's unique number, its local id number or county permit number, the well's name (usually the owner's name), or address. Simply entering a unique well number at the level 1 prompt (>>) will initiate a search for that number. **NEXT** selects the next well record in the working data base; **PREVIOUS** will access the previous record. Once a record has been selected, it may be examined using the **LIST** or **REPORT** commands. The **LIST** and **REPORT** commands function as described above except that they generate output for the selected record only rather than the entire working data base. **SET OUTPUT** and **ACCESS**, also level 0 commands described above, are available at level 1. At level 1 it is sufficient to use the first two characters of each command.

Also available at level 1 are the **UPDATE** and **CREATE** commands used for editing existing well records and creating new ones. These two commands are described in the following sections. The **END** command returns the program to level 0.

Editing data

Once a record has been selected using one of the level 1 selection commands, it may be modified, added to, or deleted using the level 1 **UPDATE** command. When using **UPDATE** or **CREATE** it is important to refer to Appendix B for descriptions of the data fields and the conventions and codes to use when entering or changing data.

Upon selecting **UPDATE** you are presented with the following options:

```
>>PLEASE ENTER A COMMAND (LEVEL 1) :
>>("HELP" FOR LIST OF COMMANDS ) : UPDATE

>>ENTER "EDIT" : TO EDIT SELECTED RECORD :
>> "UNLOAD" : TO UNLOAD SELECTED RECORD:
>> "DELETE" : TO DELETE SELECTED RECORD:
>> "DONE" : WHEN DONE : EDIT
```

When you specify **EDIT**, CWI presents the **EDIT/ADD** screen shown in Figure 11.

Figure 11 EDIT/ADD screen

CWI EDITOR. UN.NO.: 10627682. ()

EDIT ADD END ABORT

To modify the existing data in the record select EDIT either by moving the cursor to the EDIT box and hitting "Enter" or by pressing the F1 function key. The data for the selected record are then presented one form at a time on the screen.

Figure 12 Sample Edit/Data-Entry screen. Similar screens exist for each form in CWI, CWI/WL, and CWI/WC.

CWI IXFM1: PRINCIPAL DATA 1.

UN. NO. CO. FORM

TOWNSHIP RANGE SECTION SUBSECTION METHOD LOCATOR GEO-COORD. LOCATION METHOD

ELEV. METHOD QUAD DEPTH DEPTH YYYYMMDD USE STATUS

ELEVATION ELEVATION COMPLETED COMPLETED COMPLETED

OBWELL SWUDS IGWIS CORE/CUTTINGS/GEOPHYS.

ENTER NEW

CWI EDITOR. UN.NO.: 10627682. ()

EDIT ADD END ABORT

You may move about the screen using the direction arrows on the keyboard and modify the data as desired. Moving to the ENTER box (pressing F1 will move the cursor directly to the ENTER box when working on an Edit/Data-Entry screen) and hitting the *Enter* or *return* key will enter the data as shown on the screen and bring the next form

in the record to the screen for editing. When you have completed your changes to the existing data, select the MENU box (by moving to the ENTER box, then using the right arrow, followed by pressing the Enter key) to return to the EDIT/ADD menu.

If additional forms are needed to add new data to the record, select the ADD menu box, either by moving the cursor to that box and hitting the "Enter" key or by pressing F2.

The ADD menu includes boxes corresponding to the three parts of CWI - CWI, CWI/WL, and CWI/WC. Select the box for the appropriate part depending on the data to be added. Appendices A and B describe what is included in each part and which form is used to store the data. In general, information from water well records goes in either CWI or CWI/WL. Figure 13 shows which parts of the well log go in CWI and which in CWI/WL (the patterned sections on the log in the figure go to CWI/WL - the rest to CWI).

Figure 13 Water-well record. Data to CWI (no pattern) or CWI/WL (ruled sections).

STATE OF MINNESOTA DEPARTMENT OF HEALTH
MINNESOTA QUINCY WELL NO. 494191

WATER WELL RECORD
Minnesota Statutes 156A.01, 02
for Water Supply

1. WELL DEPTH (complete) _____ Date of Completion _____

2. PROPERTY OWNER'S NAME _____ Mailing Address if different than property address indicated above _____

3. WELL GRANTED? Yes No

4. NEAREST SOURCE OF POSSIBLE CONTAMINATION _____

5. WATER WELL CONTRACTOR CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Contractor Name _____ License No. _____
Address _____
City _____ State _____ Zip _____

MINN. DEPT. OF HEALTH COPY 494191

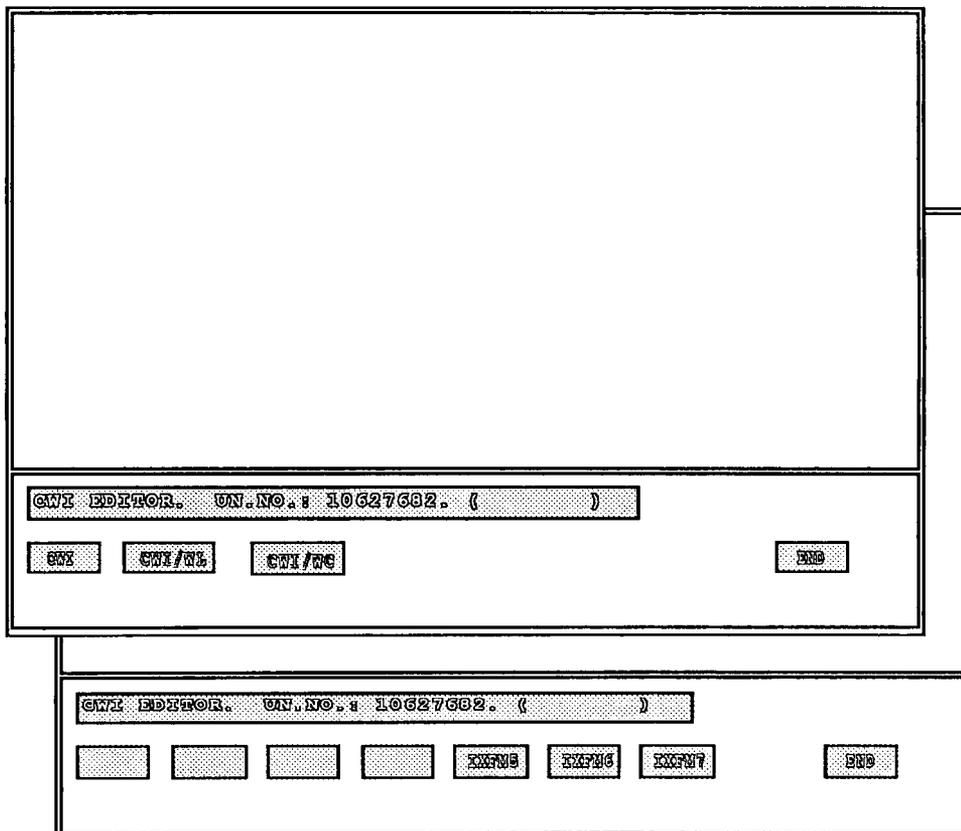
HE-8235-63 (Rev. 9/82)
6/74 800
7/76 800
7/79 800
6/82 100

Measurements of static water levels, coliform bacteria and nitrate nitrogen, and most remarks go in CWI. Water chemistry data, other than those for bacteria and nitrate, go in the CWI/WC portion.

Selecting the CWI, CWI/WL, or CWI/WC menu box will bring up another ADD menu with boxes for the different data forms available for adding data to the record. Menu boxes for non-repeating forms that are already included in the well record are blanked out. Repeating forms such as CWI Form 6, for bacteria, nitrate, and static water level data, CWI Form 7 for comments, CWI/WL Form 7 for the driller's and geologic log, and most of the CWI/WC forms are always available. Forms such as CWI Forms 2 and 3 for additional primary information, Forms 4 and 5 for addresses, and most of the CWI/WL forms, are available only if they do not already exist in the record. CWI Form 1 should never be present in the ADD menu because it will already be in the record.

To add a form to a record, move the cursor to the desired box and press *Enter* or press the function key in the position corresponding to the desired menu item (F1 activates the first menu box, F2 the second, and so on). The form selected is presented on the screen and information is added in the same manner described above for editing data.

Figure 14 ADD and CWI ADD screens



Select the MENU box to move from the ADD menu back to the menu on the EDIT/ADD screen (Fig.11). When you are finished updating the

record, select the END box from the EDIT/ADD menu. If you wish to void the additions or modifications made, select the ABORT box. Either way you will be returned to the UPDATE options (see p. 21). Entering "DONE" at this point will return you to command level 1. If updates have been made to the record, the message "DATA BASE UPDATED" will appear on the screen.

Entering new records

To enter a new record use the CREATE command. Upon entering the CREATE command, CWI will prompt for a unique number to be assigned to the new record. The unique number entered will be checked for validity and checked against the existing records in the data base. If a record with the specified unique number is found, you will be referred to the UPDATE command. UPDATE is intended for adding data to, or modifying existing data base records – CREATE is for creating new data base records.

If a record with the specified unique number is not found, CREATE will generate a blank record consisting of CWI Forms 1, 2, 3, 4, and 6, and present the EDIT/ADD screen. The EDIT function should be used to fill out the blank record forms. The ADD function should be used to add additional information, such as bacteria, nitrate, or static water level data or comments, to the CWI portion of the record or to enter CWI/WL or CWI/WC data. The use of the EDIT/ADD functions is described above in the section on editing data.

The system will need to pause and resort the data index after 100 records have been created, or when you have finished entering records. When working with very large data base files this may take up to 1 or 2 minutes - please be patient. For this reason, it is probably best to create all the new records you wish to create before leaving CREATE (since CWI will resort the data base every time you leave CREATE).

Remember that if you have edited the data base, you must end a CWI session with the END command. Failure to do so will result in damage to the data files and loss of data.

CWI Support

Questions concerning the use of CWI, requests for data files, problems with the software or data files, and suggestions for improvements should be directed to CWI Support by mail at, Minnesota Geological Survey, 2642 University Avenue, St. Paul, Minnesota 55114 or by phone at (612) 627-4780.

CWI APPLICATIONS – EXAMPLES

The whole point of collecting, correlating, and entering data into a computer system is that we can use the information to help us answer questions concerning the use and management of ground water. The previous sections described the information that is available on ground water and how to use CWI to organize it. This section covers some of the topics that CWI might help us to address and presents some examples demonstrating its use. It is important to remember, when retrieving data from CWI or any data base system, that the completeness and accuracy of the information returned from a query depends on the care and thoroughness of the data collection, correlation, and entry.

We can use CWI to address ground-water issues of different scales, from site-specific concerns, perhaps involving a particular property or a section, to problems of larger areal extent – from township-wide, to county, or even regional or state-wide. Often, using the CWI LIST or REPORT commands to display the information returned from a query to CWI is sufficient to resolve our questions. Other times, particularly when our query involves a large number of wells over a considerable area, it is more useful if the data returned can be presented in a graphical or mapped form. The information retrieved can be plotted on a map by hand or can be plotted using other computer programs. One such computer program is EPPL7. EPPL7 is the mapping software developed by the Land Management Information Center (LMIC) of the State Planning Agency. It is available through most, if not all, of the SWCD offices, and many county offices. It may also be obtained at a modest cost directly from LMIC (contact EPPL7 Coordinator, LMIC, 300 Centennial Building, St. Paul, MN 55101, tel. 612-297-2491). The last two examples below illustrate the use of EPPL7 to display data from CWI.

Site-specific Information

Searches can be made using CWI to supply a variety of information with regard to a specific site. If we would like to describe the geology for an area, the first search we might try would be to identify all wells within specific sections of a township and range. For example, a question commonly asked is, "How deep must I drill a well for drinking water?" We can get a pretty good idea by examining the depths of other wells drilled in the same or neighboring sections. The following example shows how to select and display data for wells in Township 27, Range 21, Sections 12, 13, 25 and 36 in the data base:

HELP will yield a list of the available CWI commands

```
>LEVEL 0 COMMANDS :
-----
SELECT      : SELECT WORKING DATA BASE.
ACCESS      : SET ACCESS (CWI, CWI/WL, CWI/WC).
SET OUTPUT  : SET OUTPUT DESTINATION.
LIST        : LIST WORKING DATA BASE INDEX.
REPORT      : GENERATE REPORTS FOR WORKING DATA BASE.
SORT        : SORT WORKING DATA BASE.
SELECT REC  : SELECT/UPDATE/CREATE A DATA BASE RECORD.
UNLOAD      : UNLOAD DATA FROM WORKING DATA BASE.
END         : TERMINATE SESSION.
```

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SELECT
```

```
>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" RESET TO ENTIRE DATA BASE; ) :
>("DONE" WHEN DONE SETTING CRITERIA ) : TOWNSHIP
```

```
>SELECTION BY TOWNSHIP/RANGE AND SECTION.
>ENTER NUMBER OF TOWNSHIPS(NOT MORE THAN 16) : 1
>ENTER TOWNSHIP, RANGE, AND NUMBER OF SECTIONS
>TO BE SELECTED SEPARATED BY COMMAS.
>(NUMBER OF SECTIONS=36 FOR ENTIRE TOWNSHIP)
>TWN, RNG, NO. OF SECTIONS : 27,21,4
>ENTER SECTIONS(SEPARATED BY COMMAS) : 12,13,25,36
```

Additional selection criteria could be specified at this point...

```
>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" RESET TO ENTIRE DATA BASE; ) :
>("DONE" WHEN DONE SETTING CRITERIA ) : DONE
```

```
**NUMBER OF RECORDS SELECTED : 10
```

To display 1-line listings of the data selected we use the LIST command.

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : LIST

>DO YOU WANT TO SPECIFY A FIELD TO INCLUDE IN THE LIST LINE(S)?
>(THE DEFAULT IS A PORTION OF THE NAME FIELD) : N
```

UN.NO.	CO	T-R-S	USE	DP	TH	AQU	NO3	BACT	SWEL	WL	WC	NAME
104106	82	27-21-12CBCD	DO	170	OPDC				850	Y		BILL K
104205	82	27-21-36CACA	DO	305	CSLF				700	Y		RAY HA
104207	82	27-21-13ADAD	DO	200	CJDN				830	Y		RICHAR
104231	82	27-21-36DCBB	DO	305	CJDN				675	Y		ED LUD
104238	82	27-21-12CBDC	DO	220	CJDN				843	Y		BILL K
104297	82	27-21-12CBDD	DO	140	CJDN				851	Y		O.T. M
104298	82	27-21-36CDCD	DO	315	OPDC				600	Y		DR. H.
104332	82	27-21-25DACC	DO	335	OPDC				690	Y		CHARLE
104348	82	27-21-25ACBC	DO	305	OPDC				736	Y		RICHAR
106287	82	27-21-13CBBB	DO	180	OPDC				825	Y		LEN BO

The REPORT command would display the complete information for each well.

The data can be sorted in ascending order by township for referencing to a map...

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SORT

>SORT WORKING DATA BASE.

>ENTER "A" FOR ASCENDING, "D" FOR DESCENDING : A

>ENTER FIELD NAME FOR PRIMARY SORT KEY :
>(TYPE "HELP" FOR LIST OF FIELDS ) :
```

```

>(OR HIT RETURN TO ABORT SORT)      ) : TOWNSHIP

>ENTER FIELD NAME FOR SECONDARY SORT KEY :
>("HELP" FOR LIST OF FIELDS; "NONE" FOR) :
>(NO KEY OR HIT RETURN TO ABORT SORT ) : NONE
**BEGINNING SORT**

**SORT COMPLETED**

LIST will now display the
data in ascending order

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : LIST

>DO YOU WANT TO SPECIFY A FIELD TO INCLUDE IN THE LIST LINES(S)?
>(THE DEFAULT IS A PORTION OF THE NAME FIELD) : N

UN.NO. CO T-R-S          USE DPTH AQU  NO3 BACT SWEL WL WC NAME
-----
104106 82 27-21-12CBCD DO 170 OPDC          850 Y  BILL K
104297 82 27-21-12CBDD DO 140 CJDN          851 Y  O.T. M
104238 82 27-21-12CBCD DO 220 CJDN          843 Y  BILL K
104207 82 27-21-13ADAD DO 200 CJDN          830 Y  RICHA R
106287 82 27-21-13CBBB DO 180 OPDC          825 Y  LEN BO

104348 82 27-21-25ACBC DO 305 OPDC          736 Y  RICHA R
104332 82 27-21-25DACC DO 335 OPDC          690 Y  CHARLE
104205 82 27-21-36CACA DO 305 CSLF          700 Y  RAY HA
104298 82 27-21-36CDCD DO 315 OPDC          600 Y  DR. H.
104231 82 27-21-36DCBB DO 305 CJDN          675 Y  ED LUD

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) :

```

When using these data to answer our question, we must also pay attention to the dates that the wells in that area were completed (this information is displayed when the **REPORT** command is used or the data are **LIST**ed to the printer using the **SET OUTPUT** command). In many areas in Minnesota, drillers have had to drill wells into deeper aquifers in more recent years in order to find water that is free from surface contamination. Our well may need to be deeper than older neighboring wells. If nitrate or bacteria information is available for any of the wells, it can be used to help assess water quality in the area.

Aquifer Utilization

It is often useful to see the distribution of aquifer use for a specific area. To do this search, we first select the area we are interested in, and then unload the data in a one-line ASCII format (Appendix A.4). Each index line will contain location and, if available, aquifer information. These data can then be plotted to show which aquifers are being utilized. The following example shows how to search CWI for well record data in Township 28, Range 20, Section 10. The example then shows how to unload this information for plotting:

```
>LEVEL 0 COMMANDS :
-----
SELECT      : SELECT WORKING DATA BASE.
ACCESS     : SET ACCESS (CWI, CWI/WL, CWI/WC) .
SET OUTPUT  : SET OUTPUT DESTINATION.
LIST       : LIST WORKING DATA BASE INDEX.
REPORT     : GENERATE REPORTS FOR WORKING DATA BASE.
SORT       : SORT WORKING DATA BASE.
SELECT REC : SELECT/UPDATE/CREATE A DATA BASE RECORD.
UNLOAD     : UNLOAD DATA FROM WORKING DATA BASE.
END        : TERMINATE SESSION.
```

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SELECT
```

```
>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" RESET TO ENTIRE DATA BASE; ) :
>("DONE" WHEN DONE SETTING CRITERIA ) : TOWNSHIP
```

```
>SELECTION BY TOWNSHIP/RANGE AND SECTION.
>ENTER NUMBER OF TOWNSHIPS(NOT MORE THAN 16) : 1
>ENTER TOWNSHIP, RANGE, AND NUMBER OF SECTIONS
>TO BE SELECTED SEPARATED BY COMMAS.
>(NUMBER OF SECTIONS=36 FOR ENTIRE TOWNSHIP)
>TWN, RNG, NO. OF SECTIONS : 28,20,1
>ENTER SECTIONS(SEPARATED BY COMMAS): 10
```

```
>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" RESET TO ENTIRE DATA BASE; ) :
>("DONE" WHEN DONE SETTING CRITERIA ) : DONE
```

```
**NUMBER OF RECORDS SELECTED : 8
```

The UNLOAD command is used to prepare the data for use by a mapping program.

```
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : UNLOAD
```

```
>SELECT AN UNLOAD OPTION :
>(ENTER "HELP" FOR OPTIONS):
>UNLOAD OPTION? : HELP
```

```
THE UNLOAD OPTIONS ARE :
1 - INDEX.
2 - CWI ONLY.
3 - CWI/WL ONLY.
4 - CWI/WC ONLY.
5 - ALL DATA.
6 - INDEX & ALL DATA.
7 - EPPL PLOT DATA.
```

A text data file usable by a plotting program is written to file AQUCHK on your current directory

```
>UNLOAD OPTION? : 1
```

```
**ENTER NAME FOR FILE TO RECEIVE UNLOADED INDEX: AQUCHK
```

```
**BEGINNING UNLOAD**
```

```
**WORKING DATA BASE UNLOAD COMPLETED **
```

Figure 15 Aquifer utilization in one section of Washington County.

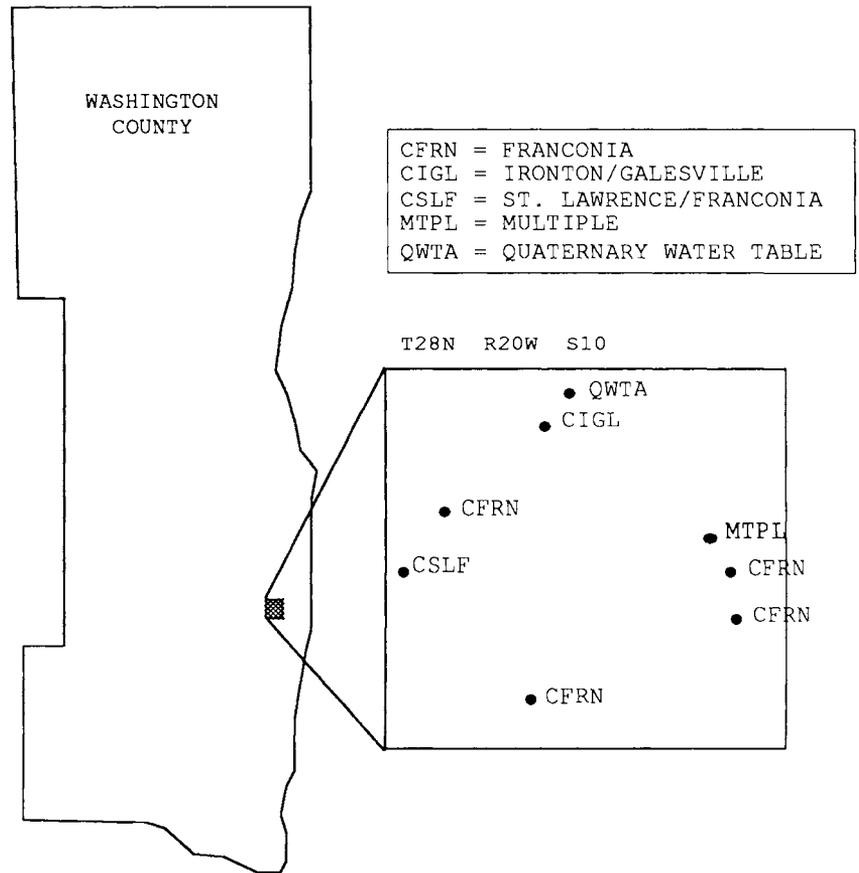


Figure 15 was generated using MGS mapping software. EPPL7 could also be used to map and display or plot the results. In that case, however, UNLOAD option 7 would be used to prepare the data for plotting. See the section "CWI and EPPL7" below for more information on how this can be done.

Other common questions concern particular aquifers. For example, we might ask, "How many wells are finished in the Jordan Sandstone in our county?" In this example, the entire county is being considered, so no further information about specific locations is required. To do this search, we select by aquifer using the SELECT command from level 0. CWI will prompt for aquifer codes to search for (aquifer codes are listed in Appendix C.2). Once the search is completed, the data can be unloaded and plotted. The following example shows how to search the county data for wells completed in the Jordan Sandstone:

*The code for the Jordan Sandstone is **CJDN** (see Appendix C.2 for aquifer / stratigraphic codes.*

*A text data file usable by a plotting program is written to file **CJDNCHK**.*

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : SELECT

>ENTER FIELD NAME FOR SELECTION CRITERIA :
>("HELP" FOR LIST OF FIELDS; ) :
>("RESET" RESET TO ENTIRE DATA BASE; ) :
>("DONE" WHEN DONE SETTING CRITERIA ) : AQUIFER

>SELECTION BY AQUIFER
>PLEASE ENTER DESIRED AQUIFER CODES
>(1 PER LINE; MAX. OF 10; HIT RETURN WHEN DONE)
>AQUIFER CODE : CJDN
>AQUIFER CODE :

**NUMBER OF RECORDS SELECTED : 19

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : UNLOAD

>SELECT AN UNLOAD OPTION :
>(ENTER "HELP" FOR OPTIONS):
>UNLOAD OPTION? : 1

**ENTER NAME FOR FILE TO RECEIVE UNLOADED INDEX: CJDNCHK

**BEGINNING UNLOAD**
** WORKING DATA BASE UNLOAD COMPLETED **

```

Again, EPPL7 or other mapping software could be used to plot the unloaded data after exiting CWI.

Direction of Ground-water Flow

The direction of ground-water flow is commonly determined by plotting the elevation of water in wells over a broad area. Ground water generally flows from areas with higher water elevations to areas with lower water elevations. CWI allows you to unload static water elevations for wells you have selected. The static water elevation for each well is calculated automatically in the data base by subtracting the depth to water in the well (static water level) from the elevation of the land surface at the well site. A well record needs both a static water level measurement and an elevation of the land surface to be used for this task.

Let us assume that we have already selected wells in a particular location using the T-R-S search discussed above. Furthermore, we have narrowed down our selection by specifying a particular aquifer (in this case the Jordan Sandstone portion of the Prairie du Chien/Jordan Aquifer) in which the wells are completed. This second condition is important, because we want the data to reflect the elevations of water in a single aquifer. Look at the data using the **LIST** command :

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : LIST

>DO YOU WANT TO SPECIFY A FIELD TO INCLUDE IN THE LIST LINE(S)?
(THE DEFAULT IS A PORTION OF THE NAME FIELD) : N

UN.NO. CO T-R-S          USE DPTH AQU  NO3 BACT SWEL WL WC NAME
-----
101034 82 27-21-33BDCB DO 245 CJDN          665 Y
104137 82 27-20-19DCD DO 245 CJDN          824 Y JOHN O
104207 82 27-21-13ADAD DO 200 CJDN          830 Y RICHA
104208 82 27-21-24AAAB DO 245 CJDN          815 Y CHARL
104231 82 27-21-36DCBB DO 305 CJDN          675 Y ED LUD

104233 82 27-22-01BDDC DO 260 CJDN          689 Y QUAD
104234 82 27-22-01CAAA DO 240 CJDN          691 Y QUAD
104235 82 27-20-14BAAC DO 275 CJDN          674 Y KEN SC
104236 82 24-20-14BCCD DO 275 CJDN        D160 Y JOE ST
104238 82 27-21-12CBDC DO 220 CJDN          Y BILL K

104250 82 27-21-33BCBC DO 220 CJDN          680 Y STAN W.
104289 82 27-20-10BCCB DO 275 CJDN          846 Y HENRY
104296 82 27-20-04BBCD DO 317 CJDN          681 Y RICK D.
104297 82 27-21-12CBDD DO 140 CJDN          851 Y O.T. M
104300 82 27-20-33DDBD DO 230 CJDN          647 Y C. R.

ENTER RETURN TO CONTINUE:
"END" TO TERMINATE LISTING : END

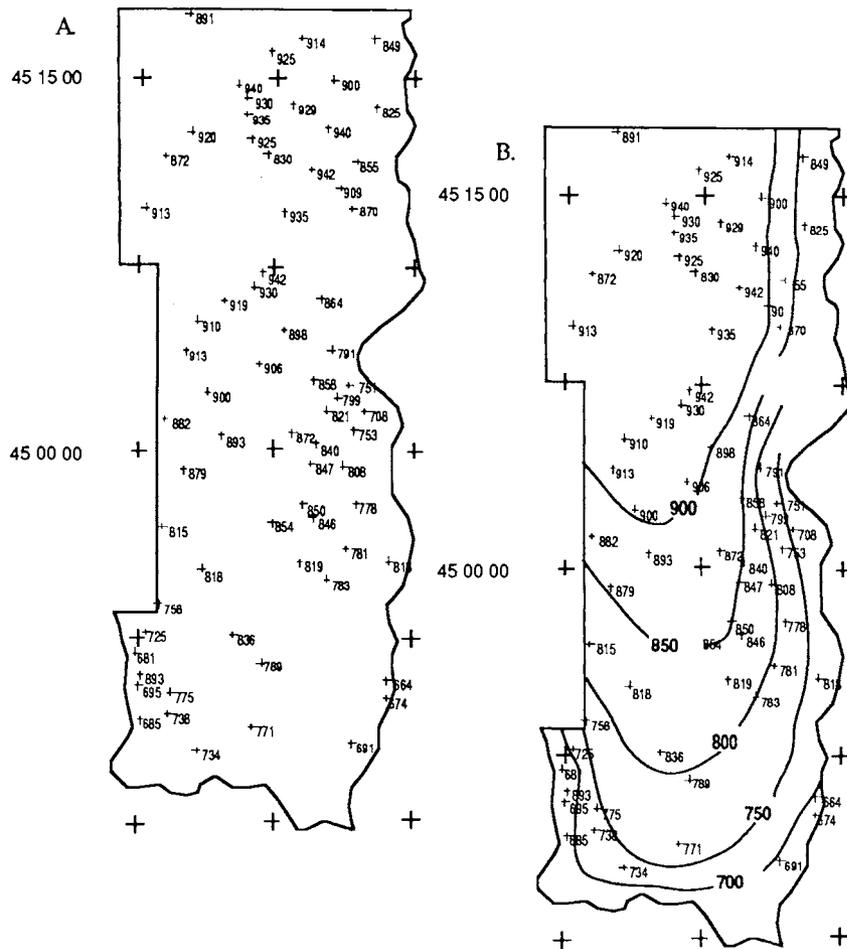
>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) :

```

In the column labeled "SWEL," note the two entries at the bottom of the second set of data. Well number 104236 shows the entry "D160" for its static water elevation. The "D" indicates that this well does not have an elevation entered in the data base that can be used to compute the static water elevation. Here, 160 feet is the depth to water for that well. Well number 104238 has no entry at all for its static water elevation. In this case, the depth to water has not been entered into the data base for this well.

Once the data are plotted, contours can be drawn in the same manner as contours are drawn from topographic elevations. Figure 16A shows static water elevations for selected Jordan wells in Washington County. In Figure 16B, the same data have been contoured at 50-foot intervals. The map shows ground water in the Jordan aquifer moving from the northern part of the county to the southeast toward the St. Croix River.

Figure 16 Jordan Sandstone part of the Prairie du Chien/Jordan aquifer in Washington County.
 A. Static water level elevations.
 B. Pieziometric surface.



It should be noted that the static water elevations contained in the data base are determined most often using the static water level on the original well record. This means that the dates of the water level measurements vary widely. Accurate maps of the pieziometric surface depend not only on the accuracy of the measurement, but on the dates that the measurements were made. Water levels in wells can change substantially during the year and from one year to the next. Therefore, unless levels were specifically measured and entered into CWI for the area of interest, caution should be used when contouring values for static water elevations. Check the date and source, if available, for all measurements used on the map.

CWI and EPPL7

EPPL7 is a geographic information system (GIS) developed by LMIC that has widespread use in Minnesota. Some simple links have been built into CWI to allow for easier plotting of selected well record data in EPPL7 format. The following examples show how to use EPPL to display aquifer and nitrate information from CWI.

Getting the data

The first of the two steps necessary to display CWI well data using EPPL7 is to run CWI, select the information we wish to view, and unload it to data files that EPPL7 can use. The first example shows how to prepare CWI data to display the different aquifers used in an area:

```

>LEVEL 0 COMMANDS :
-----
SELECT      : SELECT WORKING DATA BASE.
ACCESS      : SET ACCESS (CWI, CWI/WL, . CWI/WC) .
SET OUTPUT  : SET OUTPUT DESTINATION.
LIST        : LIST WORKING DATA BASE INDEX.
REPORT      : GENERATE REPORTS FOR WORKING DATA BASE.
SORT        : SORT WORKING DATA BASE.
SELECT REC  : SELECT/UPDATE/CREATE A DATA BASE RECORD.
UNLOAD      : UNLOAD DATA FROM WORKING DATA BASE.
END         : TERMINATE SESSION.

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS   ) : UNLOAD

>SELECT AN UNLOAD OPTION      :
>(ENTER "HELP" FOR OPTIONS):
>UNLOAD OPTION?               : HELP

THE UNLOAD OPTIONS ARE :
1 - INDEX.
2 - CWI ONLY.
3 - CWI/WL ONLY.
4 - CWI/WC ONLY.
5 - ALL DATA.
6 - INDEX & ALL DATA.
7 - EPPL PLOT DATA.

The EPPL option is chosen >UNLOAD OPTION?           : 7

>SELECT A PLOT DATA UNLOAD OPTION :
1 - AQUIFER.
2 - NITRATE.
3 - STATIC WATER ELEV.
4 - WELL LOCATIONS.

4 options are
currently available

>PLOT DATA UNLOAD OPTION?       : 1
**ENTER 3-CHARACTER ID FOR UNLOADED EPPL FILES : 82D

**BEGINNING PLOT DATA UNLOAD**

** PLOT DATA UNLOAD COMPLETED **
** UNLOADED DATA WRITTEN TO FILES:
CLASS CORRESPONDENCE TABLE FILE = EPP82D.CCT
POINT DATA FILE = EPP82D.PNT
LEGEND FILE = EPP82D.LEG
LOG FILE = EPP82D.LOG

This ID will become
part of the file names
unique to this set of
data - see discussion.

Note that the ID "82D"
has been included here.

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS   ) :

```

The second example shows how we can prepare CWI nitrate data for display via EPPL7:

```

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) : UNLOAD

>SELECT AN UNLOAD OPTION :
>(ENTER "HELP" FOR OPTIONS):
>UNLOAD OPTION? : HELP

THE UNLOAD OPTIONS ARE :
1 - INDEX.
2 - CWI ONLY.
3 - CWI/WL ONLY.
4 - CWI/WC ONLY.
5 - ALL DATA.
6 - INDEX & ALL DATA.
7 - EPPL PLOT DATA.

The EPPL option is chosen >UNLOAD OPTION? : 7

>SELECT A PLOT DATA UNLOAD OPTION :
1 - AQUIFER.
2 - NITRATE.
The option to prepare nitrate data is selected. 3 - STATIC WATER ELEV.
4 - WELL LOCATIONS.
>PLOT DATA UNLOAD OPTION? : 2
**ENTER THREE CHARACTER ID FOR UNLOADED EPPL FILES : 82E

**BEGINNING PLOT DATA UNLOAD**

>DATA VALUES RANGE FROM: 0
TO: 3

The program will automatically divide the data into 8 classes of equal intervals over the data range.
>WOULD YOU LIKE TO HAVE INTERVALS COMPUTED AUTOMATICALLY? Y

** PLOT DATA UNLOAD COMPLETED **
** UNLOADED DATA WRITTEN TO FILES:
CLASS CORRESPONDENCE TABLE FILE = EPP82E.CCT
POINT DATA FILE = EPP82E.PNT
LEGEND FILE = EPP82E.LEG
LOG FILE = EPP82E.LOG

>PLEASE ENTER A COMMAND (LEVEL 0) :
>("HELP" FOR LIST OF COMMANDS ) :

```

Note that we could have specified the class intervals rather than let CWI compute them

More than one EPPL plot unload can be done during the same CWI session. Files with their assigned ID's will be written to the current directory on your computer.

Creating an EPPL7 file

Before a set of data can be displayed using EPPL7, an EPPL file ".EPP" must be created. To create a .EPP file do the following:

1. Put the EPPxxx.CCT, EPPxxx.PNT, EPPxxx.LEG and EPPxxx.LOG created in CWI into the EPPL7 directory (using the DOS "COPY" command) on the computer. (The xxx in each of the file names is used to represent the 3-character ID that was specified for these files in CWI at the start of the EPPL unload). The file COUN.EPP, which is the county outline file, must also be on the EPPL7 directory. County

outline files and other useful EPPL7 data layers are available from LMIC.

Using EPPL7

2. Switch into the EPPL7 directory (CD\EPPL7).

3. Type "EPPL < EPPxxx.LOG"

This step creates an EPPxxx.EPP file and a file called CNTYBRD.DGT.

4. Type "DISPLAY"

The title of the EPPL7 Display program will appear. Hit *return* to proceed. A general menu like the one to the right will appear.

Draw
Color
Legend
Overlay
Help
Replay
Startlog
Endlog
New Display
Pause
Text
Wipe
+Eppl
*Dos
Quit

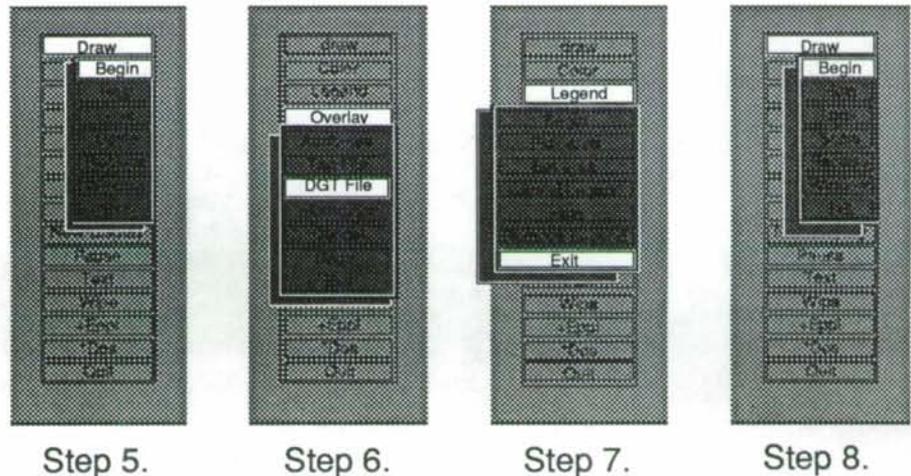
5. Use the command DRAW from the display menu to select the file EPPxxx.EPP. The program will ask for the color file. Select a color file supplied with EPPL7. Exit the DRAW submenu.

6. Add a county border to the data from the OVERLAY submenu by selecting the DGT file CNTYBRD.DGT. Exit the OVERLAY submenu.

7. Add a legend to the plot by selecting the file EPPxxx.LEG from the LEGEND submenu. Exit the LEGEND submenu.

8. Draw the plot by selecting the command BEGIN from the DRAW submenu and hitting *return* twice.

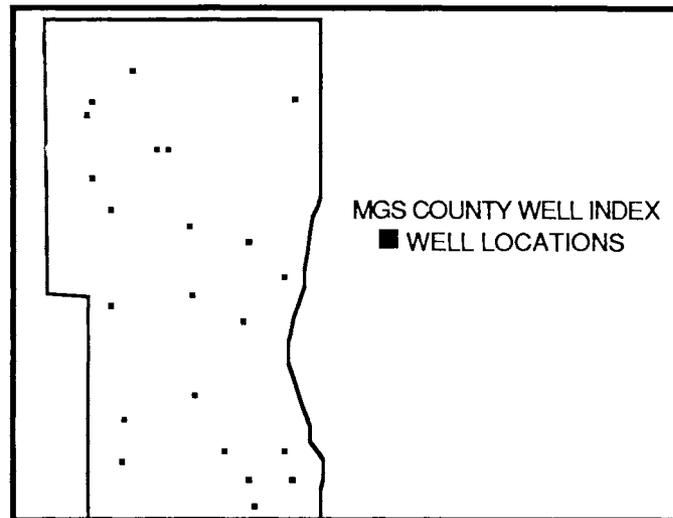
Figure 17 Screen representations of steps 5-8 in the text.



9. To see the entire county go to the sub-submenu SCALE in the DRAW submenu. Select MAX POSSIBLE, then exit. Redraw the display using the command BEGIN in the DRAW submenu.

10. At the full county scale, the dots will be small. Use the WINDOW command to zoom in on areas of interest.

Figure 18 Screen representation of EPPL7 display (only a few of the wells in this area are shown)



Once you become familiar with the file structure and commands in the EPPL7 program, the display can be refined to show greater detail. Township borders can be created in the same manner as the county border by using the EPPL command BORDER. Additional EPPL commands such as MOSAIC allow you to combine separate .EPP files into a single display. The EPPL command JUMPING WINDOWS can be used to increase the size of the dots on the display. Please contact LMIC or MGS if you have questions on how this can be done.

Description of files for creating EPPL display

The following description of the files used to create the screen display above may be of further assistance for future manipulation of the data.

-EPPxxx.LOG This file is used to automate the construction of the EPPxxx.EPP file and the CNTYBRD.DGT file.

-EPPxxx.PNT This file contains CWI data along with the Universal Transmercator, (UTM) coordinates for each point. This file is used with the COUN.EPP file to construct the EPPxxx.EPP file.

-EPPxxx.CCT This file contains a class correspondence table that assigns EPPL classes to a specified range of data.

-EPPxxx.LEG This file is contains legend information that can be used in the EPPL DISPLAY program to show class color assignments.

-CNTYBRD.DGT This file is used in the EPPL DISPLAY program to show the county border. This file was created from the COUN.EPP file supplied by LMIC. CNTYBRD.DGT should be selected as a "DGT" overlay from the OVERLAY submenu of the DISPLAY program.

Appendix A.1 Data base definition - CWI

Each well record in the County Well Index consists of one or more lines of information. Each line of information (hereafter referred to as a "form") is of a defined type or structure and is assigned a "form number" which identifies its data structure. Seven different forms are defined for CWI. All records have a Form 1 which has primary well identification information recorded on it. The record may or may not contain additional forms and may have multiple data analyses (Form 6) and/or remarks (Form 7) forms.

Form 1 – principal data 1.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
1	1-6	C*6	unique well number
1	7-8	C*2	county code
1	9	C*1	(internal code = I) ^{@1}
1	10-11	I2	form number = 1
1	12-14	I3	township
1	15-16	I2	range (west, negative if east)
1	17-18	I2	section
1	19-24	C*6	subsection codes
1	25	I1	location method code
1	26-30	C*5	locator (agency/locator)
1	31	C*1	geographic coordinates method code
1	32-35	I4	elevation (ground surface, above msl in feet)
1	36	C*1	elevation method code
1	37-40	C*4	7.5-minute quadrangle code (MGS)
1	41-44	I4	depth completed (in feet)
1	45-48	I4	depth drilled (in feet)
1	49-56	D*8	date drilled (completed as yyyyymmdd)
1	57-58	C*2	use code
1	59	C*1	status (activity) code
1	60	L*1	OBWELL flag
1	61	L*1	SWUDS flag
1	62	L*1	IGWIS flag
1	63	C*1	cuttings/core/geophysics
1	64	1x	blank
1	65	C*1	(internal code) ^{@1}
1	66	L*1	(CWI/WL flag) ^{@1}
1	67	L*1	(CWI/WC flag) ^{@1}
1	68	L*1	(CWI/UTM flag) ^{@1}
1	69-72	I4	(number of forms in record) ^{@1}
1	73-80	D*8	(last update date - yyyyymmdd) ^{@1}

Form 2 – principal data 2.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
2	1-6	C*6	unique well number
2	7-8	C*2	county code
2	9	C*1	(internal code= I) ^{@1}
2	10-11	I2	form number = 2

2	12-16	A*5	data source/driller's license number
2	17-40	C*24	well name
2	41-54	C*14	local identifier
2	55-56	C*2	local identifier type code
2	57-80	C*24	owner's/contact's name (if different from well name)

Form 3 – principal data 3.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
3	1-6	C*6	unique well number
3	7-8	C*2	county code
3	9	C*1	(internal code = I) ^{@1}
3	10-11	I2	form number = 3
3	12-13	I2	casing diameter (inches - deepest casing)
3	14-17	I4	depth cased (feet - deepest casing)
3	18	C*1	grout (Yes, No, or blank)
3	19-22	I4	potential pollution source distance (feet)
3	23-24	C*2	potential pollution source direction
3	25-27	C*3	potential pollution source type code
3	28-35	D*8	date this well abandoned (if abandoned)
3	36	C*1	another unused well on property ? (Yes, No, or blank)
3	37	C*1	sealed code, if unused well exists on property
3	38-41	C*4	aquifer code
3	42-45	I4	depth to bedrock (feet)
3	46-49	C*4	first bedrock code
3	50-53	C*4	open (non-cased) interval - top unit code
3	54-57	C*4	open interval - bottom unit code
3	58-65	A*8	permit number
3	66-67	C*2	permit type code
3	68-72	C*5	wellhead protection area code
3	73-80	C*8	DNR permit applic. # (most recent)

Form 4 – well address/user-defined fields.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
4	1-6	C*6	unique well number
4	7-8	C*2	county code
4	9	C*1	(internal code = I) ^{@1}
4	10-11	I2	form number = 4
4	12-17	A*6	house number or rural route
4	18-21	I4	street or road number -OR-
	18-37	C*20	street, road, or route name or landmark description
4	38-39	C*2	road type code
4	40-41	C*2	road direction code
4	42-61	C*20	city/town/village/hamlet
4	62-66	I5	zip code
4	67-70	I4	zip code extension
4	71-75	A*5	user-defined alpha/numeric code
4	76-78	I3	user-defined integer field

Form 5 – owner's/contact's address (if different from well address).

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
5	1-6	C*6	unique well number
5	7-8	C*2	county code
5	9	C*1	(internal code = I) ^{@1}
5	10-11	I2	form number = 5
5	12-17	A*6	house number or rural route
5	18-21	I4	street or road number -OR-
	18-37	C*20	street, road, or route name or landmark description
5	38-39	C*2	road type code
5	40-41	C*2	road direction code
5	42-61	C*20	city/town/village/hamlet
5	62-66	I5	zip code
5	67-70	I4	zip code extension

Form 6 – coliform/nitrate/static water level data.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
6	1-6	C*6	unique well number
6	7-8	C*2	county code
6	9	C*1	(internal code = I) ^{@1}
6	10-11	I2	form number = 6
6	12-16	R5.x	coliform bacteria count
6	17	C*1	detection limit code
6	18-25	D*8	bacteria count date
6	26-32	C*7	bacteria count data source
6	33	C*1	reliability code
6	34	C*1	analytic technique code
6	35-39	R5.x	nitrate nitrogen in mg/l
6	40	C*1	detection limit code
6	41-48	D*8	nitrate analysis date
6	49-55	C*7	nitrate data source
6	56	C*1	reliability code
6	57	C*1	analytic technique code
6	58-63	R6.x	static water level
6	64-71	D*8	water level measurement date
6	72-78	C*7	water level data source

Form 7 – remarks.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
7	1-6	C*6	unique well number
7	7-8	C*2	county code
7	9	C*1	(internal code = I) ^{@1}
7	10-11	I2	form number = 7
7	12-80	C*69	remarks

^{@1} indicates for internal use only (or system-generated fields)

Appendix A.2 Data base definition - CWI/WL

CWI/WL (County Well Index/Well Log) is the CWI component containing the well construction information, pumpage test data, and driller's and interpreted geologic logs from water well records.

Each well record in the CWI/WL consists of one or more lines of information. Each line of information (hereafter referred to as a "form") has a defined type or structure and is assigned a "form number" which identifies its data structure. There are seven different forms defined for CWI/WL. All records have a Form 1 which has primary well identification information recorded on it. The record may contain additional forms and may have up to 93 log (Form-7 type) forms.

Form 1 – principal data.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
1	1-6	C*6	unique well number
1	7-8	C*2	county code
1	9	C*1	(internal code = L) ^{@1}
1	10-11	I2	form number = 1
[1	12-14	I3	township] ^{@2}
[1	15-16	I2	range (west - negative if east)] ^{@2}
[1	17-18	I2	section] ^{@2}
[1	19-24	C*6	subsection codes] ^{@2}
[1	25-28	C*4	7.5-minute quadrangle code (MGS)] ^{@2}
[1	29-32	I4	elevation] ^{@2}
[1	33-36	I4	depth drilled] ^{@2}
[1	37-40	I4	bedrock elevation] ^{@2}
[1	41-44	C*4	first bedrock stratigraphic unit code] ^{@2}
[1	45-48	C*4	aquifer code] ^{@2}
[1	49-52	C*4	open (non-cased) interval - top unit code] ^{@2}
[1	53-56	C*4	open interval - bottom unit code] ^{@2}
1	57-61	A*5	geologic interpretation source (agency)
1	62-63	C*2	geologist responsible for interpretation
1	64	C*1	geologic interpretation method code
1	65-69	5L1	(flags for forms 2 - 6) ^{@1}
1	70-72	I3	(number of forms in record) ^{@1}
1	73-80	D*8	(last update date - yyyyymmdd) ^{@1}

Form 2 – well construction 1 - drilling, casing.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
2	1-6	C*6	unique well number
2	7-8	C*2	county code
2	9	C*1	(internal code = L) ^{@1}
2	10-11	I2	form number = 2
2	12	C*1	drilling method code
2	13	C*1	drilling fluid code
2	14	C*1	casing material code
2	15	C*1	casing jointing code
2	16-19	R4.x	casing top above/below(-) surface (feet)
2	20	C*1	drive shoe

2	21-24	R4.x	casing 1 - diameter (inches)
2	25-28	I4	casing 1 - from depth (feet)
2	29-32	I4	casing 1 - to depth (feet)
2	33-36	R4.x	casing 2 - diameter
2	37-40	I4	casing 2 - from depth
2	41-44	I4	casing 2 - to depth
2	45-48	R4.x	casing 3 - diameter
2	49-52	I4	casing 3 - from depth
2	53-56	I4	casing 3 - to depth
2	57	L*1	additional casing info. (see CWI remarks)
2	58	C*1	casing installation code
2	59-60	I2	drill hole 1 - diameter (inches)
2	61-64	I4	drill hole 1 - to depth (feet)
2	65-66	I2	drill hole 2 - diameter
2	67-70	I4	drill hole 2 - to depth
2	71-72	I2	drill hole 3 - diameter
2	73-76	I4	drill hole 3 - to depth

Form 3 – well construction 2 - screen.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
3	1- 6	C*6	unique well number
3	7- 8	C*2	county code
3	9	C*1	(internal code = L)@1
3	10-11	I2	form number = 3
3	12	C*1	screen present (Yes, No, or blank)
3	13-16	I4	open hole from (feet), if not screened
3	17-20	I4	open hole to , if not screened
3	21-38	C*18	make (manufacturer)
3	39	C*1	type code
3	40-43	R4.x	diameter (inches)
3	44-46	A3	screen 1: slot/gauze
3	47-50	R4.x	screen 1: length (feet)
3	51-54	I4	screen 1: setting - top depth (feet)
3	55-58	I4	screen 1: setting - bottom depth (feet)
3	59-61	A3	screen 2: slot/gauze
3	62-65	R4.x	screen 2: length (feet) 2
3	66-69	I4	screen 2: setting - top depth
3	70-73	I4	screen 2: setting - bottom depth

Form 4 – pumpage test data/driller.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
4	1- 6	C*6	unique well number
4	7- 8	C*2	county code
4	9	C*1	(internal code = L)@1
4	10-11	I2	form number = 4
4	12-17	R6.x	static water level (feet)
4	18-25	D*8	date tested (yyyymmdd)
4			Test 1
4	26-31	R6.x	pumping water level (feet)
4	32-35	R4.x	hours duration

4	36-39	I4	gallons per minute (gpm)
4			Test 2
4	40-45	R6.x	pumping water level
4	46-49	R4.x	hours
4	50-53	I4	gpm
4			Test 3
4	54-59	R6.x	pumping water level
4	60-63	R4.x	hours
4	64-67	I4	gpm
4	68-80	C*13	driller's name (last name, first initial)

Form 5 – well completion/grout.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
5	1-6	C*6	unique well number
5	7-8	C*2	county code
5	9	C*1	(internal code = L)@1
5	10-11	I2	form number = 5
5			pitless adapter
5	12-26	C*15	make (manufacturer)
5	27-32	C*6	model
5	33	L*1	basement offset
5	34	L*1	≥ 12" above ground
5	35	L*1	plastic casing protection
5			grout 1
5	36	C*1	material code
5	37-40	I4	from depth (feet)
5	41-44	I4	to depth (feet)
5	45-48	R4.x	amount
5	49	C*1	amount units code
5			grout 2
5	50	C*1	material code
5	51-54	I4	from depth
5	55-58	I4	to depth
5	59-62	R4.x	amount
5	63	C*1	amount units code
5			grout 3
5	64	C*1	material code
5	65-68	I4	from depth
5	69-72	I4	to depth
5	73-76	R4.x	amount
5	77	C*1	amount units code

Form 6 – well construction 3 - pump.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
6	1-6	C*6	unique well number
6	7-8	C*2	county code
6	9	C*1	(internal code = L)@1
6	10-11	I2	form number = 6
6	12	C*1	pump installed? (Yes, No, or blank)

6	13-20	D*8	date installed
6	21-42	C*22	manufacturer
6	43-55	C*13	model
6	56-59	R4.x	horsepower
6	60-63	R4.x	volts
6	64-67	R4.x	length of drop pipe
6	68	C*1	drop pipe material code
6	69-73	R5.x	capacity
6	74	C*1	type code

Form 7 [to 99] – driller's log/geologic interpretation.

(Form 7 is used repeatedly as needed. Increase the form number by 1 for each successive interval in the log.)

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
7-99	1- 6	C*6	unique well number
7-99	7- 8	C*2	county code
7-99	9	C*1	(internal code = L) ^{@1}
7-99	10-11	I2	form number = 7, 8, ... 99
7-99	12-44	C*33	driller's description
7-99	45-52	C*8	color
7-99	53-60	C*8	hardness
7-99	61-64	I4	depth to top of interval (feet)
7-99	65-68	C*4	interpreted stratigraphic unit (code)
7-99	69-72	C*4	interpreted primary lithology (code)
7-99	73-76	C*4	secondary lithology
7-99	77-80	C*4	minor lithology

@1 indicates for internal use only.

@2 field contents copied from CWI.

Appendix A.3 Data base definition - CWI/WC

CWI/WC (County Well Index/Water Chemistry) is the CWI component containing the results of analyses from samples taken from water wells.

Each well record in the CWI/WC consists of one or more lines of information. Each line of information (hereafter referred to as a "form") has a defined type or structure and is assigned has a "form number" which identifies its data structure. There are five different forms defined for CWI/WC. All records for a given well have one Form 1 containing minimal primary well information (more detailed well data are available through CWI and CWI/WL).

Following the Form 1, the data record may contain one or more sample records (data collected for each sampling of the water from the well). All sample records have a Form 2 which has primary sampling information recorded on it. The record may or may not have a basic parameters form (Form 3) or a remarks form (Form 4) and may have up to 95 analytical data forms (Form 5) each containing data for up to 4 parameters.

Form 1 – principal well data.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
1	1-6	C*6	unique well number
1	7-8	C*2	county code
1	9	C*1	(internal code = Q) ^{@1}
1	10-12	I3	sample record number = 0
1	13-14	I2	form number = 1
[1	15-17	I3	township] ^{@2}
[1	18-19	I2	range (west - negative if east)] ^{@2}
[1	20-21	I2	section] ^{@2}
[1	22-27	C*6	subsection codes] ^{@2}
[1	28-31	C*4	7.5-minute quadrangle code (MGS)] ^{@2}
[1	32-35	I4	elevation] ^{@2}
[1	36-39	I4	depth completed] ^{@2}
[1	40-41	C*2	use] ^{@2}
[1	42-45	C*4	aquifer] ^{@2}
[1	46-49	C*4	open (non-cased) interval - top unit code] ^{@2}
[1	50-53	C*4	open interval - bottom unit code] ^{@2}
1	54-60	7x	blank
1	61-64	I4	(last sample record number assigned) ^{@1}
1	65-68	I4	(total number of WC forms for this well) ^{@1}
1	69-72	I4	(number of sample records following) ^{@1}
1	73-80	D*8	(last update date - yyyyymmdd) ^{@1}

Form 2 – primary sample record information.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
2	1-6	C*6	unique well number
2	7-8	C*2	county code
2	9	C*1	(internal flag = Q) ^{@1}
2	10-12	I3	sample record number
2	13-14	I2	form number = 2
2	15-22	D*8	date sampled (yyyymmdd)
2	23-26	I4	sampling depth (feet)
2	27-31	A*5	sampling organization/data source code
2	32-34	A*3	sampling program code
2	35-50	A*16	sample id.
2	51-54	A*4	lab. code
2	55-70	A*16	lab. reference number
2	71-77	7x	blank
2	78-80	I3	(number of lines in sample record/Forms 2-n) ^{@1}

Form 3 – basic parameters.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
3	1-6	C*6	unique well number
3	7-8	C*2	county code
3	9	C*1	(internal flag = Q) ^{@1}
3	10-12	I3	sample record number
3	13-14	I2	form number = 3
3	15-20	R6.x	static water level (feet)
3	21-24	R4.x	temperature (°C)
3	25-32	C*8	color
3	33-37	R5.x	pH
3	38-45	R8.x	dissolved oxygen (mg/l)
3	46-53	R8.x	specific conductivity (µmhos/cm)
3	54-61	R8.x	alkalinity, Total (as CaCO ₃)

Form 4 – remarks.

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
4	1-6	C*6	unique well number
4	7-8	C*2	county code
4	9	C*1	(internal flag = Q) ^{@1}
4	10-12	I3	sample record number
4	13-14	I2	form number = 4
4	15-80	C*66	remarks

Form 5 – sample analytical data.

Form 5 is used repeatedly as needed, each form providing space for analytical results for up to four parameters. For each analysis the entry is as follows: *PARAMETER code - concentration - detection code - reliability code - technique code* .

<u>form#</u>	<u>cols.</u>	<u>type</u>	<u>field</u>
5	1-6	C*6	unique well number
5	7-8	C*2	county code
5	9	C*1	(internal flag = Q) ^{@1}
5	10-12	I3	sample record number
5	13-14	I2	form number = 5
			analysis 1
5	15-19	C*5 ^{@3}	parameter code
5	20-27	R8.x	concentration
5	28	C*1	detection code
5	29	C*1	reliability code
5	30	C*1	technique code
			analysis 2
5	31-35	C*5 ^{@3}	parameter code
5	36-43	R8.x	concentration
5	44	C*1	detection code
5	45	C*1	reliability code
5	46	C*1	technique code
			analysis 3
5	47-51	C*5 ^{@3}	parameter code
5	52-59	R8.x	concentration
5	60	C*1	detection code
5	61	C*1	reliability code
5	62	C*1	technique code
			analysis 4
5	63-67	C*5 ^{@3}	parameter code
5	68-75	R8.x	concentration
5	76	C*1	detection code
5	77	C*1	reliability code
5	78	C*1	technique code

^{@1} indicates for internal use only.

^{@2} field contents obtained from CWI.

^{@3} water chemistry codes (STORET codes developed by the EPA are used whenever possible), which also indicate the form and units of the measurement, are used as parameter codes. They are entered as integer values, right justified with preceding zeros.

Appendix A.4 Unload index file format

The CWI data base index file consists of "key" fields – named data elements, either copied directly or derived from elements of the data base – which may be used as selection and sorting criteria in data base manipulations. When the "Index" option is selected for the UNLOAD command, an ASCII text file is created which may be processed by other computer programs. The format of the unloaded file is as follows:

<u>field</u>	<u>name</u>	<u>cols.</u>	<u>type</u>	<u>description</u>
1	un.no.	1- 6	C*6	unique well number
2	county	7- 8	C*2	county code
3	township	9- 11	I3	township
4	range	12- 13	I2	range (west, negative if east)
5	section	14- 15	I2	section
6	subsection	16- 21	C*6	subsection codes
7	elevation	22- 25	I4	elevation at surface (feet above msl)
8	quad code	26- 29	C*4	7.5-min. quadrangle code (MGS)
9	use	30- 31	C*2	well use code
10	status	32	C*1	well status (activity) code
11	depth	33- 36	I4	completed well depth (feet)
12	csng diam.	37- 38	I2	minimum casing diameter
13	aquifer	39- 42	C*4	aquifer code
14	o.h.top	43- 46	C*4	open (non-cased) interval - top unit code
15	o.h.btm	47- 50	C*4	open interval bottom unit code
16	depth bdrk	51- 54	I4	depth to bedrock (feet)
17	first bdrk	55- 58	C*4	first bedrock stratigraphic unit code
18	date drlld	59- 64	D*6	date drilled (yyyymm)
19	drllr/ds	65- 69	A*5	driller/data source for well log
20	name	70- 75	C*6	first 6 characters from name field
21	address	76- 88	C*13	13-character address code created from address
22	local id.	89-102	C*14	local or alternate identifier
23	permit no.	103-110	A*8	permit number
24	whpa code	111-115	C*5	wellhead protection area code
25	user def.1	116-120	A*5	user-defined alpha/numeric code
26	user def.2	121-123	I3	user-defined integer code
27	nitrate	124-128	R5.x	nitrate nitrogen(in mg/l) - most recent analysis
28	NO3 date	129-134	D*6	nitrate analysis date (yyyymm)
29	bacteria	135-139	R5.x	coliform bacteria - most recent analysis
30	bact.date	140-145	D*6	bact. analysis date (yyyymm)
31	swl elev	146-149	I4	static water level elevation (feet above msl) - most recent
32	swl date	150-155	D*6	static water level measurement date (yyyymm)
33	ccgp	156	C*1	core/cuttings/down-hole geophysics
**CWI/WL fields				
34	pump test	157	L*1	pumpage test data available
35	capacity	158-162	R5.x	pump capacity

<u>field</u>	<u>name</u>	<u>cols.</u>	<u>type</u>	<u>description</u>
**CWI/WC fields				
36	samp.d.b.	163-170	D*8	earliest sampling date of available data.
37	samp.d.e.	171-178	D*8	most recent sampling date
38	basic	179	L*1	(some) basic parameter data available
39	micro	180	L*1	microbiologic data available
40	inorg	181	L*1	data exist for some inorganics
41	voc	182	L*1	data exist for some volatile organics
42	non-voc	183	L*1	data exist for non-volatile organics or pesticides
43	MCL	184	L*1	at least 1 parameter exceeds established MCLs
44	RAL	185	L*1	at least 1 parameter exceeds an RAL
* *				
45	entry date	186-193	D*8	date of entry
46	updated	194-201	D*8	date of last update
47	UTME	202-207	I6	Zone 15 UTM easting
48	UTMN	208-214	I7	Zone 15 UTM northing
49	UTM meth	215	C*1	method for determining UTM coordinates code

Appendix B.1 Data description and codes - CWI

Listed below are field-by-field descriptions of CWI data elements to clarify their intended use, conventions for data entry, and code definitions where appropriate. It is important to note that it is NOT necessary to fill in all of the fields when entering data. It is better to leave a data field blank than to enter uncertain or incorrect information which would compromise the quality and decrease the utility of the data base overall.

Except as indicated below, if field is

integer - right justify, preceded by blanks as needed (decimal points are not allowed).

real - right justify; decimal points allowed.

date - yyyymmdd; for example, 19780307 for March 7, 1978.

character - left justify.

alpha/numeric - right justify if numbers only; left justify if contains character(s).

flag - either blank (unflagged) or "1" to flag.

Form 1 – principal data 1.

unique well number - alpha/numeric - 6-digit Minnesota Unique Well Number or W-series number. These are very important because they permit correlation of information for a given well from a variety of sources. Bits of uncorrelated data are not nearly as useful as a full range of information for a given well. Unique numbers are coordinated by the Minnesota Geological Survey. Contact the MGS for procedures for obtaining and assigning unique numbers.

county code - character - 2-digit county identification code as listed in Appendix C.

(internal code) - character - = "I"; for internal system use.

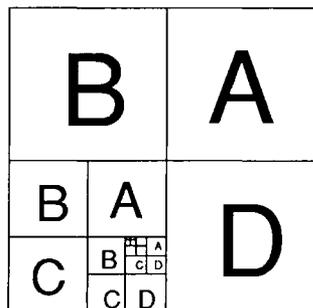
form number - integer - = 1

township - integer - public land survey township number.

range - integer - public land survey range number - negative if east (tip of Arrowhead region only).

section - integer - public land survey section number.

subsection - character - actually 6 characters indicating from largest to smallest the quarter, quarter-quarter, quarter-quarter-quarter, quarter-quarter-quarter-quarter section, and so on. The example below should have the subsection specified as *CDABBB* :



location method code - integer code - specifies how the well was field located. This is very important for determining how accurately the well's identity was determined, how accurately it was located, and how useful the data recorded for the well are for certain applications. The "located by" codes:

- 1 - address verification
- 2 - name on mailbox
- 3 - lot-block
- 4 - plat book
- 5 - info. from owner
- 6 - info. from neighbor
- 7 - other - note in *remarks*
- U - unlocated (not field located)

locator (agency/locator) - alpha/numeric - code indicating who (which organization) did the location determination. Codes used are the same as those listed below on Form 2 for *data source/driller*.

geographic coordinates method code - character - code indicating how the geographic coordinates (latitude-longitude, UTM's, or state plane coordinates) were determined for this well location. The codes are:

- A - digitized - scale 1:24,000 or larger
- B - digitized - scale 1:100,000 to 1:24,000
- C - digitized - scales smaller than 1:100,000
- D - digitized - scale unspecified/unknown
- G - GPS (Global Positioning System / satellite)
- M - manual (estimated from map or description)
- S - surveyed
- T - calculated from township-range-section
- U - calculated from township-range-section-Q
- V - calculated from township-range-section-QQ
- W - calculated from township-range-section-QQQ
- X - calculated from township-range-section-QQQQ
- Y - calculated from township-range-section-QQQQQ
- Z - calculated from township-range-section-QQQQQQ
- * - calculated from township-range-section/irregular section condition

elevation - integer - of ground surface in feet above mean sea level (usually determined from quadrangle maps - method actually used is indicated in the following field).

elevation method code - character - code indicating how the elevation was determined. Codes are modified MPCA IGWIS codes:

- A - altimeter (\pm 1 foot)
- G - GPS (Global Positioning System / satellite)
- S - surveyed
- T - 7.5-minute topographic map (\pm 5 feet)

quad code - character - MGS code for the USGS 7.5-minute quadrangle on which the well is located. Normally assigned only by MGS but should be entered if the correct code is known. This field should be *right justified*. A list of MGS quadrangle codes may be obtained, upon request, from the MGS.

depth completed - integer - finished depth of the hole in feet. Usually the same as *depth drilled* but can be less if the hole was backfilled before finishing.

depth drilled - integer - deepest depth drilled in feet from the land surface.

date drilled - date - date well installation was completed.

use code - 2 character codes (MN Well Use Codes - modified versions used by Mn PCA IGWIS and Mn Dept. of Health). The codes are as follows:

AB - abandoned	OB - observation well
AC - air conditioning	OT - other (specify in remarks)
CO - commercial	PC - community supply (municipal)*
DO - domestic	PN - public supply/non-comm.- transient*
HP - heat pump	PO - pump out well
IJ - injection	PP - public supply/non-comm.- non-transient*
IN - industrial	PS - public supply/non-community
IR - irrigation	RC - recovery well
LA - lake level augmentation	RW - relief well
MD - multiple dwelling	TW - test well
MU - municipal	UN - unknown
MW - monitor well	

* a note of clarification concerning public supply use codes. In most cases only two codes should be used - MU for municipal supply wells, and PS for other public wells such as schools, parks, and the like. Where other public supply codes are encountered they are used as follows. Public water systems are designated primarily in accordance with the EPA definitions. PC denotes wells that supply water "... for human consumption to at least 15 service connections used by year-round residents, or [one that regularly serves] at least 25 year-round residents (e.g. municipality, subdivision, mobile home park)". PS, PP, and PN all denote non-community public supply wells that supply water "... to at least 15 service connections used by individuals other than year round residents for at least 60 days a year, or serves 25 or more people at least 60 days a year ...". PP further distinguishes non-community wells as serving a largely non-transient population (e.g. schools, office buildings, factories). PN indicates non-community wells serving a largely transient population (e.g. parks, restaurants, motels, rest stops). PS does not distinguish between the transient/non-transient non-community public supply wells.

status code - 1-character code - indicates the current activity status of the well. The codes are:

A - active
I - inactive
S - sealed
T - temporarily sealed
U - unknown

OBWELL flag - flag - indicates that data for this well are contained in the DNR observation well network (OBWELL) data base.

SWUDS flag - flag - indicates that an entry for this well exists in State Water Use Data System (SWUDS).

IGWIS flag - flag - indicates existence of data for this well in the PCA Integrated Ground-Water Information System (IGWIS).

cuttings/core/geophysics - character - code indicating the availability of cuttings, core, or downhole geophysical data for the well. The codes are:

- C - core
- T - cuttings
- G - downhole geophysics
- 1 - core & cuttings
- 2 - core & geophysics
- 3 - cuttings & geophysics
- 4 - core, cuttings, & geophysics

(internal code) - character - a one-character code used internally by the system.

(CWI/WL flag) - flag - internal flag indicating presence of entry for this well in the well log portion of the CWI system.

(CWI/WC flag) - flag - internal flag indicating presence of entry for this well in the water chemistry portion of the CWI system.

(CWI/UTM flag) - flag - internal flag indicating existence of a digitized UTM location for this well.

Form 2 – principal data 2.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "I"; for internal system use.

form number - = 2

data source/driller - alpha/numeric - should indicate the source of the data being entered. Use the *driller's license number* if known, or one of the abbreviations following, or a short indication or abbreviation of your own device if necessary - try to be consistent (i.e., use the same abbreviation for the same data source). Commonly used abbreviations:

- BSU - Bemidji State University
- DNR - Department of Natural Resources
- EPA - Environmental Protection Agency
- MDA - Minnesota Department of Agriculture
- MDH - Minnesota Department of Health
- MGS - Minnesota Geological Survey
- MNDOT - Minnesota Department of Transportation
- MPCA - Minnesota Pollution Control Agency
- MSU - Mankato State University
- OCHD - Olmsted County Health Department
- PCA - Pollution Control Agency
- SCS - Soil Conservation Service
- USGS - United States Geological Survey
- WSU - Winona State University

well name - character - specifies the name of the well - last name, first name(s) or initials for domestic or privately owned wells (*Bumstead, Dagwood* for example) - company name as commonly used for commercial wells (i.e., *Dagwoods Sandwich Shop*) - as short and informative as possible for municipal, public supply, or special purpose wells (use *Rochester 7* - not City of Rochester Municipal Well Number 7 which won't fit and all the Rochester municipal wells will look like "City of Rochester Muni").

local identifier - character - alternative identifier which will uniquely determine the identity of the well or its location. Commonly used local identifiers are the property-parcel numbers used for tax purposes or emergency numbering system identifiers in some counties. These identifiers (though they may not uniquely identify a well such as in the case where two wells are located at the same property) are good because they facilitate location and correlation of data relating to a specific well. For maximum usefulness, determination of what to use for a local identifier should be done carefully and in coordinated fashion at the county level.

local identifier type code - character - 2-character code indicating the type of local identifier given in the previous field. Assigned codes:

CP - county; property-parcel id. (PIN or PID)
 CE - county; emergency services number (ESN)
 SA - state; MDA (Minn. Dept. of Ag.) number

owner's/contact's name - character - the name of the owner of the well or person responsible for the well if different from above. The same convention should be used as for *well name* above.

Form 3 – principal data 3.

unique number - see Form 1.

county code - see Form 1.

(*internal code*) - character - = "I"; for internal system use.

form number - = 3

** Note: additional information on casing and well construction may be recorded in the well log portion of the County Well Index system (CWI/WL). **

casing diameter - integer - diameter in inches of well hole or smallest diameter casing if cased. Should be rounded to nearest inch (i.e., 3.5 should be entered as " 4").

depth cased - integer - indicated deepest casing depth in feet (round up if necessary; i.e., 132.5 feet should be entered as " 133").

grout - character - Y for yes, or N for not grouted. Leave blank if no information is available; do NOT use N unless it is known that the well is not grouted.

potential pollution source distance - integer - distance in feet to nearest potential source of contamination (barnyard, fuel tank, feed lot, landfill). Intended for rough estimates for close potential sources.

potential pollution source direction - character - 1- or 2-character code indicating the direction to the nearest potential source of contamination referenced in the previous field. Codes are N, S, E, W, NW, NE, SW, and SE.

potential pollution source type code - character - 3-character code indicating the type for the potential source of contamination referred to above. The codes used are modified MPCA IGWIS codes. A partial listing includes:

ASH - ash	OPD - open dump
BYD - barnyard	PES - pesticides
FDL - feedlot	SDF - septic tank/drain field
IND - industrial	STO - storage areas
JSY - junk/scrap yard	TAN - tanks
LDF - landfill	VOC - volatile organic compounds
LIV - livestock watering	WAS - waste pile
O - other	

date this well abandoned - date - indicates the date the well was permanently sealed if this record is for a well that has been abandoned.

another, unused, well on property - character - 1-character code indicating if an abandoned or unused well is known to exist on the property - Y for yes; N for no; blank if unknown.

sealed code - character - 1-character code indicating if the unused well referenced in previous field has been sealed or not: Y - yes; P - permanently sealed; T - temporarily sealed; N - not sealed; blank - unknown or not applicable (no abandoned well on property).

aquifer - character - use stratigraphic code (Appendix C.2) for aquifer. MTPL indicates multiple aquifer with the *open-interval* top and bottom stratigraphic units given below providing information for determining which aquifer units are being drawn from. Usually assigned by MGS geologists/hydrogeologists or other qualified specialists.

depth to bedrock - integer - depth in feet to bedrock. Usually assigned by a geologist or person familiar with interpreting well logs.

first bedrock - character - code indicating the stratigraphic unit representing the first bedrock (see Appendix C.2 for code list). Usually assigned by MGS or other geologist familiar with the local stratigraphy.

open (non-cased) interval - top unit code - character - use stratigraphic code (Appendix C.2) for the uppermost geologic unit open in the well (below the casing). Usually assigned by MGS or other geologist working in the area.

open interval - bottom unit code - character - use stratigraphic code (Appendix C.2) for the lowermost geologic unit open in the well. Usually assigned by MGS or other geologist working in the area.

permit number - alpha/numeric - permit number assigned to the well assigned either by a county department or at the state level. The following field indicates what type of permit.

permit type code - character - 2-character code indicating what kind of permit the number indicated in the previous field refers to.

C - county	S - state
CH - county health	SH - state health
CP - co. planning/zoning	

wellhead protection area code - character - 5-character code indicating the wellhead protection area, if any, in which the well is located. Wellhead protection area codes are assigned by the Dept. of Health.

DNR permit application number - character - the most recent DNR permit application number, if any, associated with the well. A typical permit number might look like 78-6214 where the 78 indicates the year the permit was issued and the 62 reflects the county (in this case Ramsey)

Form 4 – well address/user-defined fields.

Address of the **well**. Put owner's address in Form 5 if desired and if different from the well address. This form also provides for two user-defined fields - one 5-character field for character, numeric or mixed codes or entries and one 3-digit integer field. These may be used however the user desires, but they will not necessarily be preserved when the data base files are transferred or merged with other CWI data bases.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "I"; for internal system use.

form number - = 4

building or route number - alpha/numeric - enter as a right-justified integer or real number (use ".5" for $1/2$) if the address has a house or building number. Specify rural routes, left justified, as "RR 10" or "RR 2" for example if possible.

street no./name/ or route name - integer/real/character - enter the street-road-avenue-highway number as an integer or real (use ".5" for $1/2$) number right justified in the first 4 columns of the field. If the street or road is named enter the name left justified and continue across the break on the entry form for the field. If the address is a named rural route as opposed to a numbered route, enter the route name here (i.e., "Star Route"). You should also use this field if the "address" is a landmark description (i.e., "NE 43AV AND HY61" to indicate the northeast corner of the intersection of 43rd Avenue and Highway 61).

road type code - character - 2-character code indicating type of road - street, avenue, boulevard, highway, etc. - using the codes as follows:

AV - avenue	HY - highway	PK - parkway
BL - boulevard	CH - county highway	PL - place
CI - circle	IH - interstate	RD - road
CR - county road	SH - state highway	ST - street
CT - court	UH - US highway	TE - terrace
DR - drive	LM - landmark	TR - trail
LA - lane	PA - path	WA - way
BN - bend	CV - curve	

** Note: it is suggested that the convention be to use the last road identifier as the "road identifier" if more than one are used in the address. For example "Treeview Circle Court Lane" would be entered as street name "Treeview Circle Court" and road identifier "LA". **

direction - character - indicates that the road specified in the address has a following direction indicator as in Abbey Road N. but NOT in North Abbey Road where "North" is considered part of the road name. Use the code *NE*, *SE*, *SW*, and *NW* for northeast, etc. and *N*, *S*, *E*, and *W* each followed by a blank for north, south, etc.

city - character - the city/town/village name as used in the mailing address.

zip - integer - the zip code.

zip extension - integer - zip code extension.

user def.1 - alpha/numeric - user-defined field. May be used in any fashion for character and/or numeric codes or entries up to five characters long.

user def.2 - integer - user-defined integer field - three places long.

Form 5 – owner's/contact's address.

Address of the well owner or the contact person if different from that of the well location. Form 4 should be used for the address of the well location.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "I"; for internal system use.

form number - = 5

building or route number - alpha/numeric - see Form 4.

street no./name/ or route name - integer/real/character - see Form 4.

road identifier - character code - see Form 4.

direction - character code - see Form 4.

city - character - see Form 4.

zip - integer - see Form 4.

zip extension - integer - see Form 4.

Form 6 – coliform/nitrate/static water-level data.

** Form 6 can be repeated to accommodate additional analyses. **

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "I"; for internal system use.

form number - = 6

coliform bacteria count - real - indicates presence or absence or count of coliform bacteria. Typical entries include actual count, 999 for positive, -99 for negative, 998 for too-numerous-to-count, -98 for unknown, or -97 for inconclusive. The most common method of reporting counts is in colonies per 100 ml or the MPN (most-probable-number) method.

detection limit code - character - indicates that the value reported in the previous field represents an upper (>) or lower (<) detection limit and the actual concentration is above or below that value.

bacteria date - date - date of sampling for coliform bacteria.

bacteria data source - character - source for bacteria analysis (abbreviation for lab. - no standards have been set, perhaps lab. certification numbers eventually; again, try to be as consistent as possible).

reliability code - character - a 1-character code indicating a non-rigorous overall estimate of the reliability of the reported analysis. Codes, which are also used here for nitrate and in CWI/WC for water chemistry, are as follows:

- 1 - use with caution
- 2 - generally low reliability or accuracy
- 3 - normal reliability
- 4 - high reliability
- 5 - exceptionally high accuracy and precision

analytic technique code - character - a 1-character code indicating the technique used for the analysis. The codes are also used for nitrate and water chemistry, and are as follows:

- | | |
|-----------------------------------|-------------------------------------|
| A - atomic absorption | H - MTF (multi-tube fermentation) |
| B - plasma source emission spect. | I - nucleopore membrane filter (MF) |
| C - spectrophotometry | J - gas chromatography |
| D - filter photometry | K - ion chromatography |
| E - mass spectrometry | L - computed |
| F - alpha scintillation | M - tube colorimetry |
| G - titration | O - other |

nitrate - real - nitrate nitrogen given in mg/l.

detection limit code - character - indicates that the value reported in the previous field represents an upper (>) or lower (<) detection limit and the actual concentration is above or below that value.

nitrate date - date - date of sampling for nitrate.

nitrate data source - see bacteria data source.

reliability code - character - see above.

analytic technique code - character - see above.

swl (static water level) - real - depth in feet from the land surface to the water level. Normally reported as an integer value (to the nearest foot) but decimal values are acceptable.

swl date - date - date static water level was measured.

swl data source - see *driller/data source* on Form 2.

Form 7 – remarks.

** Form 7 can be repeated to accommodate additional remarks. **

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "I"; for internal system use.

form number - = 7

remarks - character - free-form comments or other information not provided for otherwise. It is best to make each remark stand-alone rather than continue it from one remarks form to another because the ordering of the remarks forms may change.

Appendix B.2 Data description and codes - CWI/WL

Listed below are field-by-field descriptions of CWI/WL (the Well Log component of the County Well Index system) data elements to clarify their intended use, conventions for data entry, and code definitions where appropriate.

It is important to note that it is NOT necessary to fill in all of the fields when entering data. It is better to leave a data field blank than to enter uncertain or incorrect information which would compromise the quality and decrease the utility of the data base overall.

If field is

integer - right justify, preceded by blanks as needed (decimal points are not allowed).

real - right justify; decimal points allowed.

date - yyyymmdd; for example, 19780307 for March 7, 1978.

character - left justify.

alpha/numeric - right justify if numbers only; left justify if contains character(s).

flag - either blank (unflagged) or "1" to flag.

Form 1 – principal well data.

** Note that many of the fields for Form 1 are copied directly from, or are derived from, CWI data fields. This redundancy is to provide the information necessary for CWI/WL to operate in a stand-alone fashion. **

unique well number - 6-digit Minnesota Unique Well Number or W-series number. See CWI Form 1.

county code - 2-digit county identification code as listed in Appendix C.1.

(internal code) - character - = "L"

form number - = 1

township - integer - public land survey township number. * Copied from CWI *

range - integer - public land survey range number - negative if east (tip of Arrowhead region only).
* Copied from CWI *

section - integer - public land survey section number. * Copied from CWI *

subsection - character - 6-character subsection code - see CWI Form 1. * Copied from CWI *

quad code - MGS code for the USGS 7.5-minute quadrangle where the well is located. * Copied from CWI *

elevation - integer - of ground surface in feet above mean sea level (usually determined from quadrangle maps). * Copied from CWI *

depth drilled - integer - deepest depth drilled; in feet from the land surface. * Copied from CWI *

bedrock elevation - integer - the elevation in feet above mean sea level of the bedrock surface (if applicable - i.e., the hole penetrates bedrock). * Derived from CWI *

first bedrock stratigraphic code - character - the 4-character code (Appendix C.2) of the first bedrock geologic unit. * Copied from CWI *

aquifer code - character - 4-character code for the aquifer used - see CWI Form 2. * Copied from CWI *

open (non-cased) interval - top unit code - character - 4-character code for the first stratigraphic unit in the open-hole (non-cased) portion of the well. * Copied from CWI *

open interval - bottom unit code - character - 4-character code for the stratigraphic unit at the bottom of the well. * Copied from CWI *

geologic interpretation source (agency) - character - indicate the source of the geologic interpretation of the well log. This includes any of the fields requiring a stratigraphic or lithologic code. The codes used for the agency or organization are those listed for the CWI Form 2 - *data source/driller* field. The following field can be used together with this field to identify the geologist responsible for the interpretation.

geologist responsible for interpretation - character - 2-character code for, or initials of, geologist interpreting the log.

geologic interpretation method code - character - indicates the general method by which the geologic interpretation was performed. The codes are modified MPCA IGWIS codes:

- | | |
|---|---|
| A - inferred from geologic map | C - interpreted from corings |
| B - inferred from geophysical log | E - interpreted from corings+geophysical log |
| D - inferred from driller's log | F - interpreted from cuttings |
| G - interpreted by geologist on site | H - interpreted from cuttings+geophysical log |
| P - interpreted in context of geologic study at 1: 24,000 or larger scale | |
| Q - interpreted in context of geologic study between 1:24,000 and 1:100,000 | |
| R - interpreted in context of geologic study at 1: 100,000 or smaller scale | |
| O - other (divine inspiration/wild guess) | |

Form 2 - well construction 1 - drilling/casing.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 2

drilling method - character - drilling method codes are modified Dept. of Health and MPCA IGWIS codes:

A - air rotary	M - mud rotary
B - bucket auger	N - non-specified rotary
C - cored	O - other (note in remarks)
D - driven	P - power auger/flight auger
E - excavation (back hoe)	R - reverse rotary
F - sand point	S - screened hollow stem auger
G - dug	T - cable tool
H - hand auger	U - unknown
I - hollow stem auger	V - Vibracore/Rotasonic
J - jetted	W - water rotary

drilling fluid - character - 1-character code indicating drilling fluid used. Codes are:

W - water	F - foam
B - bentonite	R - revert
S - soap	A - additive (+ bentonite)
O - other	

casing material - character - 1-character code indicating the type of casing material used. Codes are:

B - fiberglass	O - other
C - concrete	P - plastic
F - Teflon	R - copper
G - galvanized	S - steel (black or low carbon)
I - cast iron	T - tile
L - stainless steel	U - unknown
M - mixed completion	W - wood

casing jointing - character - 1-character code indicating method of jointing sections of casing:

T - threaded
W - welded
G - glued
O - other

casing top above/below surface - real - indicate the distance from the top of the casing to the ground surface. A negative value indicates the casing top is below the surface.

drive shoe - character - code indicates presence (Y) or absence (N) of drive shoe. Left blank if unknown.

casing 1: diameter - real - diameter (in inches) of the largest casing set in the well.

casing 1: from depth - integer - depth (in feet) below the ground surface of the top of the largest casing. A negative value indicates casing extends above surface.

casing 1: to depth - integer - depth (in feet) below the ground surface of the bottom of the largest casing.

casing 2: diameter - real - diameter (in inches) of the second-largest casing set in the well.

casing 2: from depth - integer - depth (in feet) below the ground surface of the top of the second-largest casing.

casing 2: to depth - integer - depth (in feet) below the ground surface of the bottom of the second-largest casing.

casing 3: diameter - real - diameter (in inches) of the third-largest casing set in the well.

casing 3: from depth - integer - depth (in feet) below the ground surface of the top of the third-largest casing.

casing 3: to depth - integer - depth (in feet) below the ground surface of the bottom of the third-largest casing.

additional casing info - flag - indicates additional casing information available. This information should be included in CWI remarks (Form 7).

casing installation code - character - indicates how multiple casings are installed in the hole if the well is cased and more than one size of casing is used. Step-down (S) indicates that all casings extend to the surface, whereas telescoping (T) casings (no longer permitted under the well code) have segments of casings beginning at some depth down the hole. Codes for casing installation:

- C - single casing
- N - none or uncased
- O - other
- S - step-down
- T - telescoping
- U - unknown

drill hole 1: diameter - integer - diameter (in inches) of the top section of the hole (in which the largest casing is set).

drill hole 1: to depth - integer - depth (in feet) to the bottom of the widest (top) section of the hole.

drill hole 2: diameter - integer - diameter (in inches) of the second-largest section of the hole (if applicable).

drill hole 2: to depth - integer - depth (in feet) to the bottom of the second-largest section of the hole (if applicable).

drill hole 3: diameter - integer - diameter (in inches) of the third-largest section of the hole (if applicable).

drill hole 3: to depth - integer - depth (in feet) to the bottom of the third-largest section of the hole (if applicable).

Form 3 - well construction 2 - screen.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 3

screen present - character - 1-character code indicating whether a screen is installed (Y - yes), is *not* installed (N - no), or not known (left blank). This field should *not* be assigned an N unless it is known not to have a screen.

open hole from - integer - if the well is *not* screened, this field contains the distance in feet from the ground surface to the top of the uncased interval.

open hole to - integer - if the well is *not* screened, this field indicates the distance in feet from the ground surface to the bottom of the uncased interval (usually the bottom of the hole).

make - character - the make, or manufacturer, of the screen installed in the hole (if applicable).

type - character - 1-character code indicating the type of screen installed in the hole:

- G - galvanized
- L - stainless steel
- O - other (see CWI remarks)
- P - plastic
- Q - slotted pipe
- R - brass

diameter - real - the screen diameter in decimal inches.

screen 1: slot/gauze - alpha/numeric - indicates the first screen's openings in terms of slot. Slot refers to the width of screen openings in hundredths of an inch (i.e., 8 slot indicates 0.08-inch openings). Gauze refers to mesh-type screens whose openings are expressed in area terms rather than width. Gauze values should be converted to slot before entering the data using the following table:

90 gauze = 6 slot	50 gauze = 12 slot
80 gauze = 7 slot	40 gauze = 18 slot
70 gauze = 8 slot	30 gauze = 25 slot
60 gauze = 10 slot	20 gauze = 35 slot

screen 1: length - real - the length of screen 1 in decimal feet.

screen 1: setting top - integer - depth in feet below the ground surface to the top of the first screen.

screen 1: setting bottom - integer - depth in feet to the bottom of the first screen.

screen 2: slot/gauze - character - indicate the second screen's openings in terms of slot.

screen 2: length - real - the length of screen 2 in decimal feet.

screen 2: setting top - integer - depth in feet below the ground surface to the top of the second screen.

screen 2: setting bottom - integer - depth in feet to the bottom of the second screen.

** Note: additional screens (more than 2) can be described via CWI Form 7 – remarks. **

Form 4 - pumpage test data/driller.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 4

static water level - real - depth, below ground surface, of the static (or before pumping) water level in decimal feet.

date tested - date - the date the pumpage test was conducted (as *yyyymmdd*).

Test 1: pumping water level - real - depth of the water level, in decimal feet, after pumping for pumpage test 1.

Test 1: hours duration - real - the decimal number of hours of pumping for test 1 before the water level was measured.

Test 1: gallons per minute - integer - pumping rate for test 1.

Test 2: pumping water level - real - see *Test 1*.

Test 2: hours duration - real - see *Test 1*.

Test 2: gallons per minute - integer - see *Test 1*.

Test 3: pumping water level - real - see *Test 1*.

Test 3: hours duration - real - see *Test 1*.

Test 3: gallons per minute - integer - see *Test 1*.

driller's name - character - the name (last name, first initial) of the person (not the company or agency) in charge of the drilling of the well.

Form 5 - well completion/grout.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 5

pitless adapter: make - character - the make or manufacturer of the pitless adapter.

pitless adapter: model - character - enter the model name or number of the adapter.

basement offset - flag - indicate with "1" flag in this field if the well was completed with a basement offset.

≥ 12" above ground - flag - "1" flag indicates that the requirement of at least 1 foot of casing above the land surface has been observed.

plastic casing protection - flag - "1" flag indicates that suitable protection has been provided for exposed casing if plastic casing has been used.

grout 1: material - character - 1-character grouting material codes are:

- G - neat cement
- B - bentonite
- C - cuttings
- O - other

grout 1: from depth - integer - depth in feet from the land surface to the top of the grouted interval under consideration.

grout 1: to depth - integer - depth to the bottom of the grouted interval under consideration.

grout 1: amount - real - the amount in decimal units (see following field) of grout used for the interval indicated.

grout 1: amount units - character - 1-character code indicating the units referred to in reporting the grout amount in the previous field: Y = cubic yards; S = sacks.

grout 2: material - character -see *grout 1*. Pertains to a second grouted interval.

grout 2: from depth - integer - see *grout 1*.

grout 2: to depth - integer - see *grout 1*.

grout 2: amount - real - see *grout 1*.

grout 2: amount units - character - see *grout 1*.

grout 3: material - character -see *grout 1*. Pertains to a third grouted interval.

grout 3: from depth - integer - see *grout 1*.

grout 3: to depth - integer - see *grout 1*.

grout 3: amount - real - see *grout 1*.

grout 3: amount units - character - see *grout 1*.

** More than 3 grouted intervals can be noted in CWI Form 7 - remarks. **

Form 6 - well construction 3 - pump.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 6

pump installed? - character - indicates whether a pump is installed (Y = yes) or not (N = no) or information is unavailable (left blank)

date installed - date - date the pump was installed as *yyyymmdd*.

manufacturer - character - the name of the pump manufacturer (if applicable).

model - character - the model name or number of the pump installed (if applicable).

horsepower - real - the horsepower rating of the pump if known and applicable.

volts - real - the required voltage for the pump installed (if applicable).

length of drop pipe - real - the length, in decimal feet, of the drop pipe.

drop pipe material - character - a 1-character code (see codes listed for Form 2 for casing materials).

capacity - real - the rated capacity of the pump installed.

type - character - 1-character code indicating the pump type. Note that "stroke" or "cylinder" should be considered to be "reciprocating" (code Q). If the pump type is unknown the field should be left blank. The codes are Department of Health pump type codes :

A - air lift	O - other (note in CWI remarks)
B - bailer	P - piston
C - centrifugal	Q - reciprocating
G - gas lift/bladder pump	R - rotary
J - jet	S - submersible
L - peristaltic	T - turbine

Form 7 [to 99] - driller's/geologic log.

Form 7 is used repeatedly as needed to reflect the driller's description of the materials encountered while drilling the well and the geologist's (see Form 1 - geologic interpretation source, geologist, & geologic interpretation method fields) corresponding geologic interpretation. The form number is increased by one for each successive use of the form. The maximum allowable number of log intervals is 93.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "L"

form number - = 7, 8, 9, . . . 99

driller's description - character - geologic materials as described on the original well log reporting form for the interval whose top is at "*depth-to-top-of-interval*" (see below) and whose bottom is at the "*depth-to-top-of-interval*" of the following interval or the depth drilled (see Form 1) if this is the last interval described in the hole. Except for the correction of spelling errors, this should be the driller's exact description for this depth interval.

color - character - this field should contain the color of the geologic materials as described by the driller. If only one color is given, the full color name is entered. If two colors are given, hyphenate the abbreviations for the two colors (using the abbreviations given below). If three or more colors are given "VARIED" is entered for this field. Color abbreviations:

black	-	blk	gray	-	gry	white	-	wht
blue	-	blu	orange	-	orn	yellow	-	yel
brown	-	brn	pink	-	pnk	green	-	grn
red	-	red	tan	-	tan	varied	-	varied

hardness - character - indicates the subjective hardness of the materials in the interval as reported by the driller. Some abbreviation may be necessary. The following entries are standard: *V.SOFT*, *M.SOFT*, *MEDIUM*, *M.HARD*, *HARD*, *V.HARD*, where *V* is *very* and *M* is *medium*. Occasionally the hardness is reported as range such as *SFT-HRD* for *soft-to-hard*, *SFT-MED* for *soft-to-medium*, or *MED-HRD* for *medium-to-hard*.

depth to top of interval - integer - depth to the top of the interval measured in feet from the land surface.

interpreted stratigraphic unit - character - 4-character code (codes listed in Appendix C.2) indicating the geologic unit to which the interval has been assigned by the interpreting geologist or organization (see Form 1). For example an interval reported by the driller as consisting of "sandrock and soapstone" might be, in a certain setting, interpreted by the geologist as *CFRN* which indicates the Cambrian Franconia Formation. No entry indicates that the log has not been geologically interpreted.

interpreted primary lithology - character - 4-character code (codes listed in Appendix C.3) indicating most prevalent geologic material in the interval as assigned by the interpreting geologist. The following two fields are used to indicate progressively less abundant geologic materials in the interval. For the example given in the previous field the geologic interpretation for the lithology might be *SNDS* for this field and *SHLE* for the following field indicating *sandstone* and *shale* respectively, with *sandstone* being the main component.

secondary lithology - character - 4-character code (Appendix C.3) indicating the second most abundant geologic material in the interval as assigned by the interpreting geologist (see previous field).

minor lithology - character - 4-character code (Appendix C.3) describing the third most abundant geologic material in the interval (see previous two fields).

Appendix B.3 Data description and codes - CWI/WC

Listed below are field-by-field descriptions of CWI/WC (the Water Chemistry-water quality component of the County Well Index system) data elements to clarify their intended use, conventions for data entry, and code definitions where appropriate.

It is important to note that it is NOT necessary to fill in all of the fields when entering data. It is best to leave a data field blank than to enter poor or uncertain information which would compromise the quality and decrease the utility of the data base overall.

If field is:

- integer - right justify, preceded by blanks as needed (decimal points are not allowed).
- real - right justify; decimal points allowed.
- date - yyyymmdd; for example, 19780307 for March 7, 1978.
- character - left justify.
- alpha/numeric - right justify if numbers only; left justify if contains character(s).
- flag - either blank (unflagged) or "1" to flag.

The water chemistry part of CWI differs somewhat from the index (CWI) and well log (CWI/WL) parts, because the water from a well may be sampled many times and many elements or parameters measured for each sample.

Form 1 is used only once for each well in CWI/WC. It provides basic well information and internal control fields for the rest of the CWI/WC record. Each sample must have a Form 2, and as many as 999 samples can be recorded for a given well. There may be a Form 3 and a Form 4 for a sample, and as many as 95 Form 5s. Each Form 5 provides space for analytical data for as many as four parameters. Each sample is numbered sequentially by the system.

Form 1 - principal well data.

** Note that many of the fields for Form 1 are copied directly from, or are derived from, CWI data fields. This redundancy is to provide the information necessary for CWI/WC to operate in a stand alone fashion. **

unique well number - 6-digit Minnesota Unique Well Number or W-series number. See CWI Form 1.

county code - 2-digit county identification code as listed in Appendix C.1.

(internal code) - character - = "Q"

sample record number - = 0

form number - = 1

township - integer - public land survey township number. * Copied from CWI *

range - integer - public land survey range number - negative if east (tip of Arrowhead region only).
* Copied from CWI *

section - integer - public land survey section number. * Copied from CWI *

subsection - character - 6-character subsection code - see CWI Form 1. * Copied from CWI *

quad code - MGS code for the USGS 7.5-minute quadrangle where the well is located. * Copied from CWI *

elevation - integer - of ground surface in feet above mean sea level (usually determined from quadrangle maps). * Copied from CWI *

depth completed - integer - finished depth of the hole in feet. * Copied from CWI *

use code - character code - 2-character code specifying the well use - see CWI Form 1. * Copied from CWI *

aquifer code - character code - 4-character code for the aquifer used - see CWI Form 2. * Copied from CWI *

open (non-cased) interval - top unit code - character code - see CWI Form 2. * Copied from CWI *

open interval - bottom unit code - character code - see CWI Form 2. * Copied from CWI *

(last sample record number assigned) - integer - system-generated. Contains the last sample number assigned. Sample record numbers are assigned sequentially by the system and are used to link together all data associated with one water sample from this well.

(total number of WC records for this well) - integer - system-generated for internal use.

(number of sample records) - integer - system-generated for internal use. Indicates the number of samples recorded in CWI/WC for this well.

(last update date) - date - system-generated. Indicates the date of the most recent modifications to the data for this well in CWI/WC.

Form 2 - primary sample record information.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "Q"

sample record number - integer - assigned sequentially by the system. Links together all data associated with one water sample from this well.

form number - = 2

date sampled - date - the date the water sample was taken from the well.

sampling depth - integer - the depth, in feet, at which the sample was taken (if applicable).

sampling organization/data source - alpha/numeric - a 5-character code indicating the sampling organization providing the source of this data. Codes used include drillers' license numbers and the following list; new codes may be added as necessary:

BSU - Bemidji State University
 DNR - Department of Natural Resources
 EPA - Environmental Protection Agency
 MDA - Minnesota Department of Agriculture
 MDH - Minnesota Department of Health
 MGS - Minnesota Geological Survey
 MNDOT - Minnesota Department of Transportation
 MSU - Mankato State University
 OCHD - Olmsted County Health Department
 PCA - Pollution Control Agency
 SCS - Soil Conservation Service
 USGS - United States Geological Survey
 WSU - Winona State University

sampling program - alpha/numeric - a 3-character code indicating the program under which the sampling was performed. A few of the codes used are listed below. Additional codes may be created as needed.

BNS - Brown/Nicollet Sampling program
 DAP - Minn. Dept. of Agriculture Pesticide sampling program
 GWQ - PCA monitoring network
 NE - NURE (National Uranium Resource Evaluation) - East Central Minnesota
 NN - NURE - New Ulm
 NS - NURE - St. Cloud
 OCM - Olmsted County Monitoring program
 WCT - Washington County Testing program

sample id. - alpha/numeric - code assigned under the sampling program to provide a cross reference to the original data.

lab. code - alpha/numeric - code assigned to the laboratory performing the analyses.

lab. reference number - alpha/numeric - internal number assigned by the laboratory performing the analyses. Provides cross reference to original lab data.

(number of lines in [this] sample record/Forms 2-n) - integer - this form and the following parameter and remarks forms pertain to this water sample for the "sample record." This field indicates the number of lines, or forms, making up the record. Generated by the system for internal purposes.

Form 3 - basic parameters.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "Q"

sample record number - see Form 2.

form number - = 3

static water level - real - the water level (in decimal feet) in the well at the time of the sampling.

temperature - real - the water temperature in degrees C at the time of sampling.

color - character - the clarity or color of the water at the time of sampling.

pH - real - the measured acidity of the water sample.

dissolved oxygen - real - the measured dissolved oxygen reported in milligrams per liter (mg/L).

specific conductivity - real - the measured conductivity in $\mu\text{mhos/cm}$.

alkalinity, total (as CaCO₃) - real - in mg/L.

Form 4 - remarks.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "Q"

sample record number - see Form 2.

form number - = 4

remarks - character - brief free-format comments pertaining to this particular sample. More extensive comments may be included in the CWI remarks.

Form 5 - sample analytical data.

Form 5 is used repeatedly as needed to record all the parameters for which this sample was analysed. Each Form 5 provides storage for data for 4 parameters. There may be up to 95 Form 5s accommodating an unlikely 380 parameters. For each parameter the entry is: *Parameter code* - *concentration* - *detection code* - *reliability code* - *technique code*.

unique number - see Form 1.

county code - see Form 1.

(internal code) - character - = "Q"

sample record number - see Form 2.

form number - = 5

parameter code - character - Whenever possible, the codes used are the STORET codes developed by the EPA. Non-STORET codes are negative values and are listed in Appendix C.4. All of the parameter codes reflect the chemical form and units of the measurement and are entered as integer values, right justified with preceding zeros. Codes that are likely to be encountered in CWI/WC are given in Appendix C.4.

concentration - real - the measured concentration of the parameter in the sample in the units indicated by the parameter code (usually in mg/l or µg/l).

detection code - character - indicates that the value reported in the previous field represents an upper (>) or lower (<) detection limit and the actual concentration is above or below that value.

reliability code - character - a 1-character code indicating a non-rigorous overall estimate of the reliability of the reported analysis. The codes are :

- 1 - use with caution
- 2 - generally low reliability or accuracy
- 3 - normal reliability
- 4 - high reliability
- 5 - exceptionally high accuracy and precision

technique code - character - a 1-character code indicating the technique used for the analysis. The codes are:

- | | |
|---|-------------------------------------|
| A - atomic absorption | H - MTF (multi-tube fermentation) |
| B - plasma source emission spectrometry | I - nucleopore membrane filter (MF) |
| C - spectrophotometry | J - gas chromatography |
| D - filter photometry | K - ion chromatography |
| E - mass spectrometry | L - computed |
| F - alpha scintillation | M - tube colorimetry |
| G - titration | O - other |

Appendix C.1
County codes

01	AITKIN	32	JACKSON	63	RED LAKE
02	ANOKA	33	KANABEC	64	REDWOOD
03	BECKER	34	KANDIYOHI	65	RENVILLE
04	BELTRAMI	35	KITTSOON	66	RICE
05	BENTON	36	KOOCHICHING	67	ROCK
06	BIG STONE	37	LAC QUI PARLE	68	ROSEAU
07	BLUE EARTH	38	LAKE	69	ST. LOUIS
08	BROWN	39	LAKE OF THE WOODS	70	SCOTT
09	CARLTON	40	LE SUEUR	71	SHERBURNE
10	CARVER	41	LINCOLN	72	SIBLEY
11	CASS	42	LYON	73	STEARNS
12	CHIPPEWA	43	MCLEOD	74	STEELE
13	CHISAGO	44	MAHNOMEN	75	STEVENS
14	CLAY	45	MARSHALL	76	SWIFT
15	CLEARWATER	46	MARTIN	77	TODD
16	COOK	47	MEEKER	78	TRAVERSE
17	COTTONWOOD	48	MILLE LACS	79	WABASHA
18	CROW WING	49	MORRISON	80	WADENA
19	DAKOTA	50	MOWER	81	WASECA
20	DODGE	51	MURRAY	82	WASHINGTON
21	DOUGLAS	52	NICOLLET	83	WATONWAN
22	FAIRBAULT	53	NOBLES	84	WILKIN
23	FILLMORE	54	NORMAN	85	WINONA
24	FREEBORN	55	OLMSTED	86	WRIGHT
25	GOODHUE	56	OTTER TAIL	87	YELLOW MEDICINE
26	GRANT	57	PENNINGTON	88	IOWA
27	HENNEPIN	58	PINE	89	WISCONSIN
28	HOUSTON	59	PIPESTONE	90	NORTH DAKOTA
29	HUBBARD	60	POLK	91	SOUTH DAKOTA
30	ISANTI	61	POPE	92	CANADA
31	ITASCA	62	RAMSEY		

Appendix C.2 Stratigraphic (and aquifer) codes

Ages for stratigraphic units are abbreviated in CWI as follows: *UNK* - unknown; *REC* - Quaternary-Recent (Holocene); *QUA* - Quaternary-Pleistocene; *CRE* - Cretaceous; *JUR* - Jurassic; *DEV* - Devonian; *ORD* - Ordovician; *D-O* - Devonian/Ordovician; *CAM* - Cambrian; *O-C* - Ordovician/Cambrian; *C-P* - Cambrian/Precambrian; *PRC* - pre-Croixan; *PZC* - Paleozoic; *PC* - Precambrian; *PCM* - Middle Proterozoic; *PCE* - Early Proterozoic; *PCP* - Proterozoic; *PCA* - Archean.

Note that stratigraphy is not a static science and changes are to be expected over time. Some of the units listed below, particularly some Precambrian igneous and metamorphic rocks, are no longer accepted by geologists working in that area of study. They are included here as an aid in deciphering older data and are not used in assigning codes to newly interpreted data. Note also that the "stratigraphic units" for the Quaternary are descriptive rather than interpretive in nature; there is not an established system of identifiable named units for these deposits in Minnesota.

Paleozoic (pre-Cretaceous) of southeastern Minnesota

		CJDN	JORDAN	CAM	
		CJSL	JORDAN-ST.LAWRENCE	CAM	
		CSTL	ST.LAWRENCE	CAM	
DEVO	DEVONIAN, UNDIFFERENTIATED	DEV	CSLF	ST.LAWRENCE-FRANCONIA	CAM
DCVA	CEDAR VALLEY	DEV	CFRN	FRANCONIA	CAM
DCOM	CEDAR VALLEY-MAQUOKETA	D-O	CFIG	FRANCONIA-IRONTON-GALESVILLE	CAM
DCOG	CEDAR VALLEY-GALENA	D-O	CFRA	FRANCONIAN STAGE	CAM
DSPL	SPILLVILLE FORMATION	DEV	CIRN	IRONTON	CAM
DWAP	WAPSIPINICON FORMATION	DEV	CIGL	IRONTON-GALESVILLE	CAM
OMAQ	MAQUOKETA	ORD	CIGE	IRONTON-GALESVILLE-EAU CLAIRE	CAM
OMQG	MAQUOKETA-GALENA	ORD	CGSL	GALESVILLE	CAM
ODUB	DUBUQUE	ORD	CGEC	GALESVILLE-EAU CLAIRE	CAM
ODGL	DUBUQUE-GALENA	ORD	CDRE	DRESBACHIAN STAGE	CAM
OGAL	GALENA	ORD	CECR	EAU CLAIRE	CAM
OGSV	GALENA/STEWARTVILLE MBR	ORD	CEMS	EAU CLAIRE-MT.SIMON	CAM
OGPR	GALENA/PROSSER MBR	ORD	CMTS	MT.SIMON	CAM
OGCM	GALENA/CUMMINGSVILLE MBR	ORD	CAMB	CAMBRIAN, UNDIFFERENTIATED	CAM
OGDC	GALENA-DECORAH	ORD	CMSH	MT.SIMON-HINCKLEY	C-P
ODCR	DECORAH	ORD	PUDF	PALEOZOIC, UNDIFFERENTIATED	PZC
ODPL	DECORAH-PLATTEVILLE	ORD	PCRG	PRE-CROIXAN REGOLITH	PRC
OGDP	GALENA-DECORAH-PLATTEVILLE	ORD			
OPVL	PLATTEVILLE	ORD			
OPVC	PLATTEVILLE/CARIMONA MBR	ORD			
OPVM	PLATTEVILLE/MAGNOLIA MBR	ORD			
OPVH	PLATTEVILLE/HIDDEN FALLS MBR	ORD	KRET	CRETACEOUS, UNDIFFERENTIATED	CRE
OPVF	PLATTEVILLE/MIFFLIN MBR	ORD	KCLR	COLERAINE	CRE
OPVP	PLATTEVILLE/PECATONICA MBR	ORD	KWND	WINDROW	CRE
OPGW	PLATTEVILLE-GLENWOOD	ORD	KWOS	WINDROW/OSTRANDER MBR	CRE
OGWD	GLENWOOD	ORD	KWIH	WINDROW/IRON HILL MBR	CRE
OPSP	PLATTEVILLE-ST.PETER	ORD	KREG	CRETACEOUS REGOLITH	CRE
OGSP	GLENWOOD-ST.PETER	ORD	KPRR	PIERRE SHALE	CRE
OSTP	ST.PETER	ORD	KNBR	NIOBRARA	CRE
OSPC	ST.PETER-PRAIRIE DU CHIEN	ORD	KCRL	CARLILE SHALE	CRE
OPDC	PRAIRIE DU CHIEN GROUP	ORD	KCBH	CARLILE/BLUE HILL MBR	CRE
OPSH	SHAKOPEE FM(PRAIRIE DU CHIEN)	ORD	KCFP	CARLILE/FAIRPORT MBR	CRE
OPWR	SHAKOPEE/WILLOW RIVER MBR	ORD	KCCD	CARLILE/CODELL SANDSTONE MBR	CRE
OPNR	SHAKOPEE/NEW RICHMOND MBR	ORD	KGRN	GREENHORN	CRE
OPOD	ONEOTA FM(PRAIRIE DU CHIEN)	ORD	KGRS	GRANEROS SHALE	CRE
OPCJ	PRAIRIE DU CHIEN-JORDAN	O-C	KDKT	DAKOTA	CRE
ORDO	ORDOVICIAN, UNDIFFERENTIATED	ORD	KDNB	DAKOTA/NISHNABOTNA MBR	CRE

Cretaceous units; Paleozoic of western Minnesota

KDWB	DAKOTA/WOODBURY MBR	CRE
KSRC	SPLIT ROCK CREEK	CRE
JURA	JURASSIC-HALLOCK REDBEDS	JUR
OSTW	STONEWALL	ORD
OSTM	STONEY MOUNTAIN	ORD
ORRV	RED RIVER	ORD
ORWN	RED RIVER-WINNIPEG	ORD
OWIN	WINNEPEG	ORD

Quaternary/Pleistocene deposits

QUUU	PLEISTOCENE UNDIFF.	QUA
QPUU	CLAY + SAND + SILT - PEBBLY	QUA

In general Pleistocene deposit codes have the form Qxyz or Wxyz where Q indicates Pleistocene and W, more specifically, Wisconsinan deposits. x, y, and z may have any of the following designations:

x	=C	clay
	=F	sand
	=G	gravel
	=I	silt
	=H	sand + gravel
	=L	clay + sand
	=W	clay + sand + silt - pebble free
	=P	clay + sand + silt - pebbly
	=N	silt + sand and/or gravel (no clay)
	=S	peat, muck, organic-rich material
	=U	deposit type unknown or undifferentiated
y	=C	contains predominantly calcareous pebbles
	=P	contains predominantly Precambrian pebbles
	=S	contains predominantly shale pebbles
	=U	materials undifferentiated or sorting unknown
	=N	unsorted
	=O	poorly sorted
	=D	moderately sorted
	=W	well sorted
z	=B	brown
	=G	gray
	=K	black
	=R	red
	=U	color unknown or unspecified
	=Y	yellow

For example, QPUB, is used for a brown pebbly deposit of clay with some sand and/or silt of unknown material composition or sorting. Note that "pebbly" as used above indicates larger than sand-size grains and could include gravel, pebbles, cobbles, and/or boulders.

Quaternary/Recent (Holocene) deposits

RMMF	MAN-MADE FILL	REC
RUUU	RECENT DEPOSIT	REC

In general Holocene deposit codes have the form Rxyz where R denotes Recent or Holocene deposits and x, y, and z may have any of the codes specified for Pleistocene deposits.

Precambrian

PCUU	PRECAMBRIAN, UNDIFFERENTIATED	PC
PCCR	PRECAMBRIAN CRYSTALLINE ROCKS	PC

Precambrian (Archean)

[equivalent to old PW-- codes]

PAAU	ALGOMAN GRANITES UNDIVIDED	PCA
PAAR	ARGO GNEISS	PCA
PABL	BELLINGHAM GRANITE	PCA
PABR	BURNTSIDE GNEISS	PCA
PADL	DEER LAKE COMPLEX	PCA
PAES	SOUDAN IRON-FORMATION	PCA
PAEY	ELY GREENSTONE	PCA
PAFR	FORT RIDGLEY GRANITE	PCA
PAGR	GIANTS RANGE GRANITE UNDIVIDED	PCA
PAGF	GRANITE FALLS GNEISS	PCA
PAKG	KNIFE LAKE GROUP	PCA
PALL	LAC LACROIX GRANITE	PCA
PALV	LAKE VERMILION FORMATION	PCA
PAMC	MCGRATH GNEISS	PCA
PAMV	MONTEVIDEO GNEISS	PCA
PAMR	MORTON GNEISS	PCA
PANL	NEWTON LAKE FORMATION	PCA
PAOD	ODESSA GRANITE	PCA
PAOR	ORTONVILLE GRANITE	PCA
PARG	RICHMOND GNEISS	PCA
PASW	ST.WENDEL METAGABBRO	PCA
PASH	SACRED HEART GRANITE	PCA
PASG	SAGANAGA TONALITE	PCA
PASR	SAUK RAPIDS META. COMPLEX	PCA
PAST	SARTELL GNEISS	PCA
PASF	SEAFORTH GNEISS	PCA
PAUD	ARCHEAN ROCKS UNDIVIDED	PCA
PAVC	VERMILION GRANITIC COMPLEX	PCA
PAWT	WATAB AMPHIBOLITE	PCA
PAGU	ARCHEAN GRANITE PLUTON	PCA

Precambrian (Early Proterozoic)

[equivalent to old PX-- codes]

PEAG	ANIMIKIE GROUP	PCE
PEBI	BIWABIK IRON-FORMATION	PCE
PEBC	BRADBURY CREEK GRANODIORTE	PCE
PECM	CEDAR MOUNTAIN COMPLEX	PCE
PEDN	DENHAM FORMATION	PCE
PEFH	FREEDHEM GRANODIORITE	PCE
PEGT	GLEN TOWNSHIP FORMATION	PCE
PEGI	GUNFLINT IRON-FORMATION	PCE
PEHL	HILLMAN MIGMATITE	PCE
PEIL	ISLE GRANITE	PCE
PELF	LITTLE FALLS FORMATION	PCE
PEMN	MAHNOMEN FORMATION	PCE
PEML	MILLE LACS GROUP	PCE
PEPZ	PIERZ GRANITE	PCE
PEPK	POKEGAMA QUARTZITE	PCE
PERB	RABBIT LAKE FORMATION	PCE
PERL	RABBIT LK.FM-LOWER MEMBER	PCE
PERE	RABBIT LK.FM-EMILY MEMBER	PCE
PERU	RABBIT LK.FM-UPPER MEMBER	PCE
PERF	REFORMATORY GRANITE	PCE
PERK	ROCKVILLE GRANITE	PCE
PERD	RANDALL FORMATION	PCE
PERV	ROVE FORMATION	PCE
PESC	ST.CLOUD GRANITE	PCE
PEST	STEARNS GRANITIC COMPLEX	PCE
PETM	THOMSON FORMATION	PCE
PETR	TROMMALD FORMATION	PCE
PETL	TROUT LAKE FORMATION	PCE
PEUD	EARLY PROTEROZOIC ROCKS UND.	PCE
PEVR	VIRGINIA FORMATION	PCE
PEWR	WARMAN GRANITE	PCE
PEGU	E.PROTEROZOIC GRANITE PLUTON	PCE
PEYV	PROTEROZOIC BASALT DIKES	PCP

PMRC	RED CLASTIC SERIES	PCM
PMSX	SIOUX QUARTZITE	PCM
PMSC	SOLOR CHURCH FORMATION	PCM
PMPR	PIGEON RIVER INTRUSIONS	PCM
PMUD	MIDDLE PROTEROZOIC ROCKS UND.	PCM
PMVU	KEWEENAWAN VOLCANICS UND.	PCM
PMSU	MID.PROTEROZOIC SEDIMENTARY	PCM

Miscellaneous codes

QBAA	QUAT. BURIED ARTES. AQUIFER	QUA
QBPA	QUAT. BURIED PERCHED AQUIFER	QUA
QBUA	QUAT. BURIED UNCONF. AQUIFER	QUA
QTTA	QUAT. AQUITARD	QUA
QWPA	QUAT. PERCHED AQUIFER	QUA
QWTA	QUAT. WATER TABLE AQUIFER	QUA
UREG	WEATHERING RESIDUUM	UNK
BSMT	BASEMENT	
MTPL	MULTIPLE AQUIFER	
NA	NOT APPLICABLE	
NRCD	NO RECORD	
PITT	PIT	
PVMT	PAVEMENT	

Precambrian (Middle Proterozoic)

[equivalent to old PY-- codes]

PMBB	BEAVER BAY COMPLEX	PCM
PMCV	CHENGWATANA VOLCANIC GROUP	PCM
PMDC	DULUTH COMPLEX	PCM
PMDA	DULUTH CPLX-ANORTH.SERIES	PCM
PMDF	DULUTH CPLX-FELSIC SERIES	PCM
PMDT	DULUTH CPLX-TROCT.SERIES	PCM
PMFL	FOND DU LAC FORMATION	PCM
PMHF	HINCKLEY-FOND DU LAC	PCM
PMHN	HINCKLEY SANDSTONE	PCM
PMLG	LOGAN INTRUSIONS	PCM
PMNP	NOPEMING SANDSTONE	PCM
PMNS	NORTH SHORE VOLCANIC GROUP	PCM
PMPK	PUCKWUNGE FORMATION	PCM

Appendix C.3 Lithologic codes

ADAM	ADAMELLITE	DLMT	DOLOMITE
AGLM	AGGLOMERATE	DOLE	DOLERITE
ALKB	ALKALI BASALT	DRFT	DRIFT
ALKG	ALKALI GRANITE	DUNT	DUNITE
ALKR	ALKALI RHYOLITE	DURI	DURICRUST
ALKS	ALKALI SYENITE	ECLO	ECLOGITE
ALKT	ALKALI TRACHYTE	FCLP	FELDSPATHIC CLINOPYROXENITE
ALQS	ALKALI QUARTZ SYENITE	FDUN	FELDSPATHIC DUNITE
ALQT	ALKALI QUARTZ TRACHYTE	FELS	FELSITE
ALSK	ALASKITE	FGRD	FERROGRANODIORITE
ALUV	ALLUVIUM	FILL	FILL
AMPH	AMPHIBOLITE	FLNT	FLINT
ANDS	ANDESITE	FOCL	FELDSPATHIC OLIV. CLNOPYROXENITE
ANGB	ANORTHOSITIC GABBRO	FOPY	FELDSPATHIC OLIVINE PYROXENITE
ANNR	ANORTHOSITIC NORITE	FORP	FELDSPATHIC ORTHOPYROXENITE
ANOG	ANORTHOSITIC OLIVINE GABBRO	FPRH	FELDSPATHIC PERID. (HARZBURGITE)
ANOR	ANORTHOSITE	FPRW	FELDSPATHIC PERID. (WEHRLITE)
ANPT	ANORTH. PYROXENE TROCTOLITE	FRDI	FERRODIORITE
ANTR	ANORTHOSITIC TROCTOLITE	FRGB	FERROGABBRO
APLT	APLITE	GBAN	GABBROIC ANORTHOSITE
AREN	ARENITE	GBRO	GABBRO
ARGI	ARGILLITE	GNDI	GRANODIORITE
ARKS	ARKOSE	GNIS	GNEISS
BDRK	BEDROCK	GNLT	GRANULITE
BENT	BENTONITE	GOSS	GOSSAN
BLDR	BOULDER	GOUG	GOUGE
BRNZ	BRONZITE	GRAN	GRANITE
BSLT	BASALT	GRPH	GRANOPHYRE
BSMT	BASEMENT (BUILDING)	GRSC	GREENSCHIST
BXSD	BRECCIA, SEDIMENTARY	GRSN	GREENSTONE
BXTT	BRECCIA, TECTONIC	GRST	GRAINSTONE
CARB	CARBONATE	GRVL	GRAVEL
CATA	CATACLASTITE	GRWK	GRAYWACKE
CHAR	CHARNOCKITE	GYPG	GYPG
CHLK	CHALK	HARZ	HARZBURGITE
CHLR	CHLORITE, CHLORITIC	HDPN	HARDPAN
CHRT	CHERT	HNBT	HORNBLENDITE
CLAY	CLAY	HNFL	HORNFELS
CLPX	CLINOPYROXENITE	INSU	INTERFLOW SEDIMENTS, UNDEF.
CLSN	CLAYSTONE	IRFM	IRON FORMATION
CNGL	CONGLOMERATE	IRON	IRON ORE
COAL	COAL	JASP	JASPER
COBL	COBBLE	KAOL	KAOLINITE, KAOLINITIC
COLV	COLLUVIUM	KERA	KERATOPHYRE
CRBT	CARBONITITE	KIMB	KIMBERLITE
CRVC	CREVICE	KOMA	KOMATIITE
CVRN	CAVERN	LAMP	LAMPROPHYRE
DACT	DACITE	LATI	LATITE
DIAB	DIABASE	LATR	LATERITE
DIOR	DIORITE	LGNT	LIGNITE

LHRZ	LHERZOLITE	QRTZ	QUARTZITE
LMSN	LIMESTONE	QUTZ	QUARTZ, QUARTZOSE
LOAM	LOAM	QZAN	QUARTZ ANDESITE
LOES	LOESS	QZAR	QUARTZ ARENITE
MAFU	MAFIC, UNDEF.	QZDI	QUARTZ DIORITE
MARB	MARBLE	QZLA	QUARTZ LATITE
MARL	MARL	QZMD	QUARTZ MONZODIORITE
MDSN	MUDSTONE	QZMZ	QUARTZ MONZONITE
MELI	MELILITITE	QZPY	QUARTZ PORPHYRY
MGBR	MELAGABBRO	QZSY	QUARTZ SYENITE
MGMT	MIGMATITE	QZTR	QUARTZ TRACHYTE
MICR	MICRITE	REGO	REGOLITH
MMUO	MAN-MADE UGRND OBSTRUCTION	RHYD	RHYODACITE
MMUV	MAN-MADE UNDERGROUND VOID	RHYL	RHYOLITE
MNOR	MELANORITE	SAND	SAND
MNZZ	MONZONITE	SAPR	SAPROLITE
MUCK	MUCK	SERP	SERPENTINITE
MUDD	MUD	SHLE	SHALE
MXTA	MIXED TROCTOLITE/ANORTHSTE	SHST	SCHIST
MYLN	MYLONITE	SIDR	SIDERITE, SIDERITIC
NEPH	NEPHELINITE	SILT	SILT
NOAN	NORITIC ANORTHOSITE	SINT	SINTER
NORT	NORITE	SKRN	SKARN
NRCO	NO RECORD	SLSN	SILTSTONE
OBSD	OBSIDIAN	SLTE	SLATE
OBTR	OLIVINE-BEARING TROCTOLITE	SNDS	SANDSTONE
OLCL	OLIVINE CLINOPYROXENITE	SOIL	SOIL
OLGB	OLIVINE GABBRO	SPAR	SPARITE
OLMG	OLIVINE MELAGABBRO	SYEN	SYENITE
OLPX	OLIVINE PYROXENITE	TACT	TACONITE
OOLT	OOLITE	THOL	THOLEIITE
OPHI	OPHIOLITE	TILL	TILL, TILLITE
ORGD	ORGANIC DEPOSITS	TONT	TONALITE
ORGN	ORTHOGNEISS	TRAN	TROCTOLITIC ANORTHOSITE
ORPX	ORTHOPYROXENITE	TRAV	TRAVERTINE
ORQZ	ORTHOQUARTZITE	TRAY	TRACHYTE
OVBD	OVERBURDEN	TRDJ	TRONDHJEMITE
PEAT	PEAT	TRGB	TROCTOLITIC GABBRO
PEBL	PEBBLES	TROC	TROCTOLITE
PEGM	PEGMATITE	TUFA	TUFA
PELT	PELITE	TUFF	TUFF
PHON	PHONOLITE	UMFU	ULTRAMAFICS, UNDEF.
PHOS	PHOSPHATIC	VOLU	VOLCANICS, UNDEF.
PHYL	PHYLLITE	WATR	WATER
PICR	PICRITE	WOOD	WOOD
PITT	PIT		
PRDH	PERIDOTITE (HARZBURGITE)		
PRDT	PERIDOTITE		
PRDW	PERIDOTITE (WEHLITE)		
PUMC	PUMICE		
PVMT	PAVEMENT (MAN-MADE)		
PYPC	PYROXENE PICRITE		
PYRX	PYROXENITE		
PYTR	PYROXENE TROCTOLITE		

Appendix C.4 Water chemistry codes

STORET codes developed by the EPA are used if possible. Parameter codes less than zero have been assigned if no STORET code was available. Most of the parameter codes given below are for whole water samples. *-T* indicates *total*; *-D* indicates *dissolved*; *-S* indicates *suspended* state. Units are usually given as MG/L (milligrams per liter) or UG/L ($\mu\text{g/L}$ - micrograms, or 10^{-6} grams per liter). Other abbreviations are MEQ (milliequivalents per liter), MF (membrane filter), /MIL (per 1000), /100ML (per 100 milliliters), 10/ML (tens per milliliter), MV (millivolts), PCI/L (picocuries per liter), PCT (percent), UM/CM (micromhos per centimeter), and YRS (years).

Basic parameters

			00690	CARBON-T	MG/L
			00691	CARBON(INORG)-D	MG/L
00410	ALKALINITY(AS CaCO_3)-T	MG/L	00685	CARBON(INORG)-T	MG/L
00440	BICARBONATE	MG/L	82087	C13/C12	/MIL
01022	BORON-T	UG/L	28004	C14(DATE)	YRS
00916	CALCIUM-T	MG/L	82172	C14(PERCENT MODERN)	PCT
00940	CHLORIDE(AS CL)	MG/L	00445	CARBONATE ION CO_3	MG/L
00094	CONDUCTIVITY(FIELD)	UM/CM	01030	CHROMIUM-D	UG/L
00951	FLUORIDE-T	MG/L	01034	CHROMIUM-T	UG/L
00900	HARDNESS(AS CaCO_3)-T	MG/L	01035	COBALT-D	UG/L
01045	IRON-T	UG/L	01037	COBALT-T	UG/L
00927	MAGNESIUM-T	MG/L	31612	COLIFORM, FECAL	10/ML
01055	MANGANESE-T	UG/L	31502	COLIFORM, T	10/ML
71850	NITRATE(AS NO_3)-T	MG/L	31625	COLIFORM, T, MF	/100ML
71855	NITRITE(AS NO_2)-T	MG/L	01040	COPPER-D	UG/L
00660	ORTHOPHOS.(AS PO_4)-T	MG/L	01042	COPPER-T	UG/L
00937	POTASSIUM-T	MG/L	00090	EH(OX-RED POTENTIAL)	MV
00956	SILICA(AS SiO_2)-T	MG/L	00950	FLUORIDE-D	MG/L
00929	SODIUM-T	MG/L	-1002	H/D	/MIL
00945	SULFATE(AS SO_4)-T	MG/L	82041	HELIUM(AS HE)	UG/L
70304	TOTAL DISSOLVED SOLIDS	MG/L	01046	IRON-D	UG/L

Miscellaneous, inorganics, & metals

00431	ALKALINITY(FIELD)-T	MG/L	01049	LEAD-D	UG/L
00415	ALKALINITY(P)	MG/L	01051	LEAD-T	UG/L
00425	ALK.(BICARB.AS CaCO_3)	MG/L	01130	LITHIUM-D	UG/L
00430	ALK.(CARB.AS CaCO_3)	MG/L	01132	LITHIUM-T	UG/L
01106	ALUMINUM-D	UG/L	00925	MAGNESIUM-D	MG/L
01105	ALUMINUM-T	UG/L	01056	MANGANESE-D	UG/L
00619	AMMONIA	UG/L	71890	MERCURY-D	UG/L
01000	ARSENIC-D	UG/L	71900	MERCURY-T	UG/L
01002	ARSENIC-T	UG/L	01060	MOLYBDENUM-D	UG/L
01005	BARIUM-D	UG/L	01062	MOLYBDENUM-T	UG/L
01007	BARIUM-T	UG/L	01065	NICKEL-D	UG/L
01010	BERYLLIUM-D	UG/L	01067	NICKEL-T	UG/L
01012	BERYLLIUM-T	UG/L	71851	NITRATE(AS NO_3)-D	MG/L
01020	BORON-D	UG/L	71856	NITRITE(AS NO_2)-D	MG/L
71870	BROMIDE	MG/L	00600	NITROGEN(AS N)-T	MG/L
01025	CADMIUM-D	UG/L	00625	NITROGEN(KJELDAHL)-T	MG/L
01027	CADMIUM-T	UG/L	71889	ORTHOPHOS.(AS PO_4)-D	MG/L
00915	CALCIUM-D	MG/L	82085	O18/O16	/MIL
			00666	PHOSPHOROUS-D	UG/L
			00665	PHOSPHOROUS-T	UG/L
			00935	POTASSIUM-D	MG/L

09503	RADIUM 226-D	PCI/L	81757	CYANAZINE	UG/L
09501	RADIUM 226-T	PCI/L	39570	DIAZINON	UG/L
82303	RADON 222	PCI/L	38437	DIBROMOCHLOROPROPANE-T	UG/L
01187	SCANDIUM-D	UG/L	38442	DICAMBA(BANVEL)-D	UG/L
01189	SCANDIUM-T	UG/L	38443	DICAMBA(BANVEL)-S	UG/L
01145	SELENIUM-D	UG/L	39380	DIELDRIN-T	UG/L
01147	SELENIUM-T	UG/L	39010	DISULFOTON(FLAME PHOTO)	UG/L
00955	SILICA(AS SIO2)-D	MG/L	81888	DISULFOTON	UG/L
01140	SILICON-D	UG/L	82617	DISULFOTON-RECOVBL	UG/L
01142	SILICON-T	UG/L	39390	ENDRIN-T	UG/L
01075	SILVER-D	UG/L	81894	EPTC(EPTAM)	UG/L
01077	SILVER-T	UG/L	-1004	FONOFOS	UG/L
00930	SODIUM-D	MG/L	39410	HEPTACHLOR-T	UG/L
00095	SPECIFIC CONDUCTANCE	UM/CM	38477	LINURON-T	UG/L
01080	STRONTIUM-D	UG/L	30192	MCPA-RECOVBL	UG/L
01082	STRONTIUM-T	UG/L	39600	METHYL PARATHION	UG/L
82086	S34/S32	/MIL	39356	METOLACHLOR(DUAL)	UG/L
00946	SULFATE(AS SO4)-D	MG/L	81408	METRIBUZIN(SENCOR)-T	UG/L
26403	THORIUM-D	UG/L	-1005	PENTACHLOROPHENOL	UG/L
01150	TITANIUM-D	UG/L	46313	PHORATE	UG/L
01152	TITANIUM-T	UG/L	78881	PHOSPHAMIDON(DIMECRO)	UG/L
-1000	TOTAL ANIONS	MEQ	39720	PICLORAM	UG/L
-1001	TOTAL CATIONS	MEQ	30295	PROPACHLOR-RECOVBL	UG/L
07005	TRITIUM-D	PCI/L	39055	SIMAZINE	UG/L
07000	TRITIUM-T	PCI/L	39760	SILVEX	UG/L
22703	URANIUM-D	UG/L	81284	TRIFLURALIN-T	UG/L
28011	URANIUM-T	UG/L	39730	2,4-D.	UG/L
82087	U238/U234		39740	2,4,5-T.	UG/L
01085	VANADIUM-D	UG/L	81859	2,4,5-T.&SILVEX	UG/L
01087	VANADIUM-T	UG/L	39045	2,4,5-TP.	UG/L
01201	YTTRIUM-D	UG/L			
01203	YTTRIUM-T	UG/L			
01090	ZINC-D	UG/L			
01092	ZINC-T	UG/L			
01160	ZIRCONIUM-D	UG/L			
01162	ZIRCONIUM-T	UG/L			
<i>Pesticides</i>					
77825	ALACHLOR-T	UG/L			
46342	ALACHLOR-D	UG/L			
39053	ALDICARB	UG/L			
82619	ALDICARB-RECOVBL	UG/L			
39330	ALDRIN-T	UG/L			
39033	ATRAZINE	UG/L			
39153	ATRAZINE &/OR SIMAZINE	UG/L			
81410	BUTYLATE(SUTAN)-T	UG/L			
30236	BUTYLATE-RECOVBL	UG/L			
39640	CAPTAN	UG/L			
77700	CARBARYL-T	UG/L			
81405	CARBOFURAN(EURADAN)	UG/L			
82615	CARBOFURAN-RECOVBL	UG/L			
39350	CHLORDANE(TECH.MX+)	UG/L			
38932	CHLORPYRIFOS-T-RECOVBL	UG/L			
				<i>Non-volatile organics</i>	
			00681	CARBON(ORG)-D	MG/L
			00680	CARBON(ORG)-T	MG/L
			-1006	DIALLATE	UG/L
			32730	PHENOLS-T	UG/L
			32732	PHENOLS-D	UG/L
			32733	PHENOLS-S	UG/L
			34694	PHENOL(C6H5OH)-T	UG/L
			39516	PCBS-T	UG/L
			30335	PCBS-D	UG/L
			30336	PCBS-S	UG/L
				<i>Volatile organics</i>	
			81552	ACETONE	UG/L
			78109	ALLYLCHLORIDE-T	UG/L
			34030	BENZENE-T	UG/L
			34235	BENZENE-D	UG/L
			34236	BENZENE-S	UG/L
			81555	BROMOBENZENE	UG/L
			32101	BROMODICHLOROMETHANE	UG/L
			32104	BROMOFORM	UG/L

30202	BROMOMETHANE-RECOVBL	UG/L
32102	CARBON TETRACHLORIDE	UG/L
34301	CHLOROBENZENE-T	UG/L
34306	CHLORODIBROMOMETHANE	UG/L
32106	CHLOROFORM-T	UG/L
77970	CHLOROTOLUENE	UG/L
81522	DIBROMOETHANE	UG/L
81524	DICHLOROBENZENE	UG/L
34668	DICHLORODIFLUOROMETHANE	UG/L
81680	DICHLOROETHANE	MG/L
81328	DICHLOROETHENE	UG/L
81327	DICHLOROPROPANE	UG/L
78113	ETHYL BENZENE	UG/L
77223	ISOPROPYLBENZENE	UG/L
81595	METHYL ETHYL KETONE	UG/L
34423	METHYLENE CHLORIDE-T	UG/L
34696	NAPHTHALENE	UG/L
77224	N-PROPYLBENZENE	UG/L
77128	STYRENE	UG/L
81549	TETRACHLOROETHANE	UG/L
81607	TETRAHYDROFURAN	UG/L
34010	TOLUENE-T	UG/L
78170	TRICHLOROBENZENE	UG/L
81853	TRICHLOROETHANE	UG/L
34488	TRICHLOROFLUOROMETHANE	UG/L
81610	TRICHLOROPROPANE	UG/L
81611	TRICHLOROTRIFLUOROETHANE	UG/L
78136	TRIMETHYL BENZENE	UG/L
39175	VINYL CHLORIDE-T	UG/L
34020	XYLENES	UG/L

**Voir le document
physique pour le(s)
Disquette(s)**

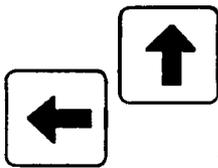
**See physical
document for
Disket(s)**

CWI version 3.0 Release Notes

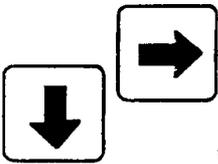
The following notes provide additional documentation reflecting changes or additions to CWI since the companion manual, "Ground-water Data Management/The County Well Index" was published June, 1991.

October, 1991

- use of cursor (arrow) keys, function keys, and PageUp/PageDown.
The keys listed below have the described effects when working with the CWI Entry/Edit screens :



moves the cursor to the *preceding* field or menu box;



moves the cursor to the *next* field or menu box;



moves the cursor to the next field or selects (or activates) the menu box in which the cursor is located;



selects the corresponding menu box when the cursor is in the menu area; F10 always selects the *last* menu box;



moves the cursor to the "ENTER" box when the cursor is currently in the form editing area of the screen;



brings up the *next* data form when editing data (note that changes made on a form will not be reflected unless the "ENTER" box is selected - do not use "PageDown" if you have made changes on a form that you wish to keep);

**Page
Up**

brings up the *previous* data form when editing data (see caution for "PageDown" above);

control

**Page
Down**

scrolls *down* the help list of water chemistry parameter codes when editing/adding data to CWI/WC Form 5;

control

**Page
Up**

scrolls *up* the help list of water chemistry parameter codes;

- The SUBSELECT command will be implemented in CWI version 3.1.
- to install CWI:
 - change to the drive with the CWI distribution disk by entering "A:" or "B:", whichever is appropriate;
 - type

INSTALL x:

followed by return. Replace the "x" with the letter designating the hard drive you wish to have CWI on (usually "C" - try using "C" if you're not sure).

see pages 12 and 13 in the CWI manual for additional notes on installing and running CWI.

December, 1991

- Geologic Interpretation - **CAUTION**:- Form 1 of CWI/WL contains fields for indicating by whom (agency and geologist) the geologic interpretation was done and the method employed. The geologic interpretation is evident in the following fields: aquifer, first bedrock, open hole top and bottom stratigraphic units, and the stratigraphy and lithology fields in the downhole log portion in CWI/WL. The best interpretations are those done from examination of core and/or geophysical logs in the context of a large scale geologic study. The least reliable are those done only from a driller's log and not within the context of a geologic study, or within the context of a very small scale general assessment. The quality of other methods will likely be somewhere in between.

Note that geologic interpretations for well records in CWI with the *geologist responsible for interpretation* indicated as XX and the *geologic interpretation method* code indicated as X are **provisional interpretations** and should be treated as such - that is, they **should not be used without further confirmation** for critical or site-specific applications. Interpretations for

records with blanks in the aforementioned fields and in the *geologic interpretation source* field should likewise be used with caution.

The geologic interpretations will be upgraded over time as further studies are completed and the codes modified in CWI to reflect those changes. Ultimately the provisional and blank interpretation codes should all be replaced and reflect the actual method and reliability for the geologic interpretations.

March, 1992

● **CWIX - large version of CWI:** CWI normally can handle data for up to 8000 wells. This limitation is imposed by the memory management of DOS, the system software that runs PC-compatible computers. Currently, the data bases for 2 counties - Hennepin and Anoka - contain data for more than 10,000 wells. A version of CWI that will handle these larger data sets is distributed along with the data bases that require it. It is used in the same manner as CWI but to begin execution, type "CWIX" instead of "CWI". Note that certain trade-offs had to be made to provide for handling larger data sets. CWIX is much slower than CWI in performing sorts as requested by the SORT command or when re-sorting during data entry or certain edit functions, and also requires some additional disk space for a work area. Therefore, if you are using CWI with data base files for a number of different counties, it is best to use the regular CWI program rather than CWIX whenever possible.