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INSTRUCTIONS FOR USING THE HYDRODAT COMPUTER-ORIENTED SYSTEM FOR THE STORAGE AND RETRIEVAL OF GROUNDWATER DATA

by

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PREFACE

The ever-increasing volume of geologic and hydrologic data being collected by the Groundwater Division required that a system of storage and retrieval be devised to handle these data in an efficient and economical manner.

The HYDRODAT computer-oriented storage and retrieval system was developed by the Division to evaluate the applications of electronic data-processing techniques as applied not only to information storage, but to user-oriented retrieval methods.

ACKNOWLEDGMENTS

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COMPUTER-ORIENTED SYSTEM FOR THE STORAGE AND RETRIEVAL OF GROUNDWATER DATA

INTRODUCTION

This manual describes the HYDRODAT computer-oriented magnetic tape system developed by the Groundwater Division for the storage, retrieval, and statistical analysis of groundwater data. The system is a modification of a format developed by the U.S. Geological Survey Water Resources Division, and is the outgrowth of a pilot study conducted by the Groundwater Division to evaluate the potential and feasibility of electronic data-processing techniques.

The basic elements of the HYDRODAT system are: a well-schedule form for the recording and coding of data, and a series of punch cards for transferring the encoded data to magnetic tape.

The system has been designed to meet the proposed compatibility requirements set forth by the Water Research Branch of the Department of Energy, Mines and Resources. Gilliland (1966) suggests that participating agencies follow a standard format which will allow for the integration of individual systems. The creation of master files on magnetic tape by participating agencies will allow for the interchange of basic data. These master files do not contain data as such, only the location and type of data available. Participating agencies or organizations requiring information need only search these master tapes to determine the location and type of information available. The collecting agency, upon request, would then supply the appropriate data tapes together with an explanation of the file structure, sorting and retrieval procedures.

The master file is created in accordance with the following recommended format:

Field 1	Columns 1-4	Agency/data code
Field 2	Columns 5-20	Index number
Field 3	Columns 21-35	Location, UTM system

Field 1 specifies the collecting agency and available data. In the HYDRODAT system "AR" designates the Research Council of Alberta and the numerical digits indicate the type of data available according to the following code:

10 - location, ownership, and well-description data
20 - hydrogeologic data
30 - chemical quality-of-water data
40 - lithologic data

Thus, AR30 indicates that quality-of-water data is available at the Research Council of Alberta.

Field 2 is reserved for an index number distinctive to the collecting agency. In the HYDRODAT system the index number is the location of the well according to the Alberta land surveys system, e.g. township, range, section, and legal subdivision. A three-digit sequential number is included to give each item in the file a unique index number.

The third and last field is the geographical location of the well as expressed by the Universal Transverse Mercator System (UTM). The "military grid" as it is more commonly known, is used because of its worldwide acceptance and adaptability to computer-oriented X-Y plotters.

The well-schedule form is divided into four major sections, each section being identified by an agency/data code and keyed to the punch cards by means of numbered boxes in which the numerical or coded data are inserted. The numbered boxes correspond to the columns of the punch cards used to transfer the data to magnetic tape. Data obtained during field inventory, from drillers' reports, and from chemical quality-of-water analyses are recorded on the well schedule in the appropriate boxes.

The data recorded in the first part of the schedule (AR10) locates, identifies, and describes such physical characteristics of the well as elevation, depth, casing information, and well yield.

Information relative to the physiographic units, drainage basin, topographic setting, and descriptive data about the aquifer are recorded in the hydrogeologic section (AR20). Partial data on the chemical characteristics of the water yielded by the well are recorded in this section also.

The section designated AR30 is used for recording chemical quality-of-water data. Routine chemical analyses obtained from the Provincial Analyst, commercial laboratories, or by field-testing methods are entered in this section. Subroutines for calculating equivalents, total anions, cations, and percentages are inherent in the system.

The last section (AR40) is used to record the lithologic descriptions of the rock units penetrated by the well. A condensed version of the HYDRODAT well schedule is available for those who wish to use the system for the storage and analysis of lithologic data obtained from seismic shot holes, structure test holes, and oil and gas wells.

The facilities of the University of Alberta computing center are used for processing the data. Completed well schedule forms are submitted to the computing center where keypunch operators transfer the coded information directly from the schedule to punch cards. The encoded data is then transferred to magnetic tape and the schedules and punch cards returned to the Groundwater Division for filing. Information pertaining to approximately 50,000 wells can be permanently stored on one reel of magnetic tape. Should a tape be accidently lost or destroyed a duplicate can be made from the punch cards on file and, conversely, new cards can be generated from the tape.

The use of this system is expected to result in savings of manpower in that the actual requirements for handling data will reduce substantially. Various pieces of peripheral equipment will provide for automating the preparation of data reports and will assist greatly in preparing analytical evaluations necessary for interpretations of the groundwater resources of an area. More sophisticated results will be possible through the use of computer-oriented X-Y plotters.

Opportunities for technical application of this system are numerous once the data are on magnetic tape. Many manipulations can be made which are beyond the limits of the professional or technician if he were to try to perform them manually.

WELL SCHEDULE FORM

The instructions contained in this manual have been written primarily for the use of Division personnel engaged in preparing the well schedule form. Space is provided for recording most of the information normally obtained during test-drilling programs, well inventories, and from drillers' reports and chemical quality-of-water analyses. The blank space on the inside of the well schedule may be used to record data not contained in the body of the schedule, such as casing and perforation records, information on well stimulation, or detailed descriptions of the well location.

The well schedule form is divided into four major sections, each section being identified by the following agency/data code:

AR10 - location, ownership, and well-description data
AR20 - hydrogeologic data
AR30 - chemical quality-of-water data
AR40 - lithologic data.

The information recorded on the well schedule is entered in the appropriate boxes which are keyed to the punch cards by means of the small number at the top of the box. The numbered boxes correspond to the columns of the punch cards used to transfer the numerical or coded data to magnetic tape. The printed categories, such as "ownership," "use of well," and "method drilled," enable recording much of the data by circling the appropriate category, thus reducing the amount of writing required. If information contained in sections AR20 and AR30 is obtained for more than two aquifers, separate forms should be used to record these data using consecutive decimal integers of the sequential number.

To insure accuracy and conformity, the following coding procedures have been established:

1. Use capital letters only.
2. The number "0" is written "Ø" to distinguish it from the letter "O".
3. A vertical line is used to indicate the number "1" and a vertical line with crossbars at top and bottom is used to designate the letter "I".
4. The letter "Z" is written "Ƶ" to distinguish it from the number "2".
5. Care should be taken when coding the letter "Q"; it is sometimes punched as the number "Ø".

Remember, the keypunch operators who convert your data to cards are not trained geologists and engineers; they depend on you for legible and accurate coding.

The following discussion describes the information to be recorded for each item on the well schedule and the procedures used for coding those items recorded in a coded form.

AR10 - LOCATION, OWNERSHIP, AND WELL DESCRIPTION

The data recorded on this section of the well schedule locates, identifies, and describes such physical characteristics of the well as elevation, depth, casing information, yield, etc.

RECORDED BY

The name of the person who obtains the data and fills in the schedule should be recorded in this space. When preparing a new schedule using data from an existing record, indicate the source from which the information was obtained, eg. Cardex, Dept. of Agriculture drillers' report, John Smith, etc. The name of the person preparing the schedule from existing records should enter his name in brackets following this information.

DATE

Record the month, day, and year in which the data were obtained. Normally, this will be the date the first information about the well is collected.

MAP-AREA

Record in this space the N.T.S. designation for the map-sheet on which the well has been located.

LOCATION

Enter in this space the location of the well according to the Alberta land surveys system, eg. township, range, section, and legal subdivision. A more detailed description of the location may be given on the blank space on the inside of the schedule.

The description of the location should be sufficiently detailed so that a person who has never visited the well can find it from information on the schedule.

Therefore, it is important to describe the well with reference to easily identified landmarks or physical features of a relatively permanent nature.

INDEX NUMBER

AR10
5

In the HYDRODAT system the function of the index number is twofold: first, it locates the well according to the Alberta land surveys system and secondly, when used in conjunction with the sequential number, gives each well a unique address identifying all punch cards belonging to the same observation.

The township, considered the prime indicator in most geographical filing systems is entered in boxes 5-7. This is followed by the range in boxes 8-9, with the appropriate meridian being entered in box 11. The section is entered in boxes 12-13, and the legal subdivision in boxes 14-15. Provision is made to enter a quarter section designation in boxes 14-15 if the legal subdivision is not known. If neither the legal subdivision or quarter section is known, enter 00 in boxes 14-15.

The order in which the wells are filed is as follows:

Township

Range

Section

Legal Subdivision
- NE
- NW
- SE
- SW
- 00
- 01
- 02
- .
- .
- .
- 16

Sequential number

HYDRODAT WELL SCHEDULE

Research Council of Alberta

Groundwater Division

1 A R I O 4 Recorded by: ______, Date: ______, Map area: ______

LOCATION: ______ Lsd. ______, Sec. ______, Tp. ______, Rg. ______, W. ______

Index number: 5 ☐☐☐ Tp. 8 ☐☐ W Rg. 12 ☐☐ Sec. 14 ☐☐ Lsd. Sequential number: 16 ☐☐ 18 ☐ Accuracy: 19 ☐

Source of data: 20 ☐ UTM location: 21 ☐☐ zone 23 ☐☐☐☐☐☐ easting 29 ☐☐☐☐☐☐☐ 35 northing

OWNERSHIP AND USE: Owner or name: ______

Owner or name: 36 ☐☐☐☐☐☐☐☐☐☐☐☐ 47 Address: ______

Ownership: (1) Federal, (2) Provincial, (3) City, (4) Corp. or Co., (5) Private, (6) Irr. Dist., (7) RCA, (9) Other ______ 48 ☐

Use of water: (1) P.S., (2) com.-ind., (3) dom., (4) irr., (5) stock, (6) recharge, (7) waste, (8) unused, (9) other ______ 49 ☐

Use of well: (1) withdraw, (2) test, (3) obs., (4) oil-gas, (5) seismic, (6) recharge, (7) destroyed, (8) unused, (9) other ______ 50 ☐

WELL DESCRIPTION: Driller: ______ Date drilled: ______

Elevation of land surface (LS): ______ ft. 51 ☐☐☐☐ 54 Accuracy: (source) ______ 55 ☐

Depth of well: ______ ft. 56 ☐☐☐☐ 59 Meas. (1) Repr. (2) ______ 60 ☐

Casing: length ______ ft. 61 ☐☐☐ 63 Type: ______, OD ______ in. 64 ☐☐

Well finish: (1) perf., (2) perf. (gravel), (3) screen, (4) screen (gravel), (5) sd. point, (6) cribbed, (7) open hole, (8) spring, (9) other ______ 66 ☐

Method drilled: (1) air rot., (2) bored, (3) cable, (4) dug, (5) driven, (6) hyd. rot., (7) rev. rot., (8) jetted, (9) air percussion, other ______ 67 ☐

Pump setting: ______ ft. 68 ☐☐☐ 70 Pump type and power: ______ 71 ☐

Yield: ______ igpm 72 ☐☐☐☐ 75 Test period: 76 ☐☐ Specific capacity: igpm/ft. 78 ☐☐ Accuracy: 80 ☐

1 A R 2 O 4 5 SAME AS CARD ARIO 18

HYDROGEOLOGIC ENVIRONMENT:

Physiographic region: ______ 19 ☐ Province: ______ 20 ☐

Subdivision: ______ 21 ☐☐ Section: ______ 23 ☐

Primary drainage basin: ______ 24 ☐ Drainage basin: ______ 25 ☐ Subbasin: ______ 26 ☐ 27 ☐

Topographic setting: (D) local depression; (C) stream channel; (E) dunes; (F) flat; (H) hilltop; (S) hillside; (L) lake, swamp, or marsh; (T) terrace; (U) undulating; (V) valley flat ______ 28 ☐

Tp. ______, Rg. ______, W. ______, Sec. ______, Lsd ______

HYDRODAT LITHOLOGIC SCHEDULE

Research Council of Alberta

Groundwater Division

○ 1 A R 1 0 4 Index number: 5 ☐☐☐ 8 ☐☐ W ☐ 12 ☐☐ 14 ☐☐ Sequential number: 16 ☐☐ 18

Tp. Rg. Sec. Lsd.

Location accuracy: 19 ☐ Source of data: 20 ☐ UTM location: 21 ☐☐ 23 ☐☐☐☐☐☐ 29 ☐☐☐☐☐☐ 35

zone easting northing

Owner or name: 36 ☐☐☐☐☐☐☐☐☐☐☐☐ 47 Use of well: (2) test, (4) oil-gas, (5) seismic 50 ☐

Elevation of land surface: (LS) (ft. 51 ☐☐☐☐ 54 Elevation accuracy: Source: 55 ☐

○ 1 A R 2 0 4 5 SAME AS CARD AR10 18 Depth to top of bedrock: ft. 39 ☐☐☐ 41 Source: 42 ☐

○ 1 A R 3 0 4 5 SAME AS CARD AR10 18 If no chemical data.– insert "1" in box 19 19 ☐

○ 1 A R 4 0 4 5 SAME AS CARD AR10 18 If no lithologic data – insert "1" in box 19 19 ☐

LITHOLOGIC LOG:

Interval (feet)		Lithology	Code
______	20 ☐☐☐ 22	______ lithology, ______ adjective, ______ adjective, ______ color	23 ☐☐☐☐ 26
______	27 ☐☐☐ 29	______, ______, ______, ______	30 ☐☐☐☐ 33
______	34 ☐☐☐ 36	______, ______, ______, ______	37 ☐☐☐☐ 40
______	41 ☐☐☐ 43	______, ______, ______, ______	44 ☐☐☐☐ 47
______	48 ☐☐☐ 50	______, ______, ______, ______	51 ☐☐☐☐ 54
______	55 ☐☐☐ 57	______, ______, ______, ______	58 ☐☐☐☐ 61
______	62 ☐☐☐ 64	______, ______, ______, ______	65 ☐☐☐☐ 68
______	69 ☐☐☐ 71	______, ______, ______, ______	72 ☐☐☐☐ 75

○ 1 A R 4 1 4 5 SAME AS CARD AR10 18 If no lithologic data – insert "1" in box 19 19 ☐

______	20 ☐☐☐ 22	______, ______, ______, ______	23 ☐☐☐☐ 26
______	27 ☐☐☐ 29	______, ______, ______, ______	30 ☐☐☐☐ 33
______	34 ☐☐☐ 36	______, ______, ______, ______	37 ☐☐☐☐ 40
______	41 ☐☐☐ 43	______, ______, ______, ______	44 ☐☐☐☐ 47
______	48 ☐☐☐ 50	______, ______, ______, ______	51 ☐☐☐☐ 54
______	55 ☐☐☐ 57	______, ______, ______, ______	58 ☐☐☐☐ 61
______	62 ☐☐☐ 64	______, ______, ______, ______	65 ☐☐☐☐ 68
______	69 ☐☐☐ 71	______, ______, ______, ______	72 ☐☐☐☐ 75

Additional lithologic information available – insert "1" in appropriate box

Detailed lithologic log 76 ☐ Electric log 77 ☐ Other ______ 78 ☐

Surficial material: ______ [29] Infiltration characteristics: ______ [31]

Uppermost bedrock fm.: ______ (system), ______ (series) [32] ______ (formation or group) [34]

Lithology: ______ [36] Origin: ______ [38]

Depth to top of bedrock: ______ ft. [39–41] Source: ______ [42]

Area of downward flow (1); Area of upward flow (2); Area of transitional flow (3); Uncertain (4) ______ [43]

AQUIFER:

______ (system) ______ (series) [44] ______ (member, formation, or group) [46]

Lithology: ______ [48] Origin: ______ [50] Aquifer thickness: ______ ft. [51–53]

Length of well open to aquifer: ______ ft. [54–56] Depth to top of aquifer: ______ ft. [57–59]

Intervals screened: ______

Water-table aquifer (1), Artesian aquifer (2), Unknown (3) ______ [60]

AQUIFER CHARACTERISTICS:

Coefficient of transmissibility: ______ igpd/ft [61–63] Coefficient of storage: ______ [64–66]

WATER LEVEL: Describe reference point (RP) ______ which is ______ ft. above below LS

Water level: ______ ft. above below RP; Water level: ______ ft. above below LS [67–70] Accuracy: [71]

Date measured: ______ [72–74] mon. year

QUALITY OF WATER:

color: ______ [75] odor: ______ [76] turbidity: ______ [77]

Hardness: Soft (1), medium (2), hard (3) ______ [78] Specific conductivity: ______ $\times 10^6$ [79] Fit for human consumption: yes(1) no (2) ______ [80]

[1–4] A R 3 O [5–18] SAME AS CARD ARIO no chemical data-insert "1" in box 19 [19]

CHEMICAL ANALYSIS OF WATER (ppm):

Date sampled: [20] [21] [23] mon. day year Type analysis: [25] Sampling depth: [26–28] Total dissolved solids: [29–33]

Ignition loss [34–37] Hardness: [38–41] SO_4 [42–45] Cl [46–49]

Alkalinity [50–53] NO_2 [54] NO_3 [56–58] Fe [59] HCO_3 [61–64]

CO_3 [65–67] Ca [68–71] Mg [72–74] Na+K [75–78] F [79]

Keypunch operator ______ Date ______ Verified ______

SEQUENTIAL NUMBER

AR10
16

The number "1" should be given to the first well for which a record is obtained in the legal subdivision designated by the index number. Provision is made to record a maximum of 99 wells per legal subdivision with the sequential number being entered in boxes 16-17. Box 18 is reserved to enter a decimal integer indicating additional AR20 and AR30 cards representing multiple aquifer and quality-of-water data pertaining to the same well.

Example:	Index Number	Sequential Number
First well in Lsd. and one aquifer	028 18W4 36 12	01.0
2nd aquifer	028 18W4 36 12	01.1
3rd aquifer	028 18W4 36 12	01.2

LOCATION ACCURACY

AR10
19

The accuracy with which the well is geographically located should be entered in box 19 according to the following code:

1	Location determined by precise surveying techniques and accurate within 1 meter
2	Field and map locations both accurate to nearest 20 meters (1:50,000 and 1:25,000 NTS map-series with UTM grid)
3	Field and map locations both accurate to nearest 200 meters (1:250,000 NTS map-series with UTM grid)
4	Location accurate to nearest legal subdivision
5	Location accurate to nearest quarter section
6	Location accurate to nearest section

SOURCE OF DATA

AR10
20

Indicate the source from which the data required to fill in that portion of the well schedule pertaining to the physical attributes of the well are obtained. The types of data which fall into this category are: ownership, use, well description, water level, quality of water, lithology, etc. The source of this information may be by personal observation, landowner, driller, water superintendent, consulting engineer, other governmental agencies, or personal observation by Division personnel. This information should be entered in box 20 according to the following code:

Code		Mnemonic Code
1	Data obtained by observation of well construction by RCA personnel	RSCHCNL
2	Data obtained by observation of existing well and communication with owner by RCA personnel	QUALIFD
3	Data obtained from Water Resources Driller Reports	DRLRPRT
4	Data supplied by oil, gas, mining, or other industry engaged in subsurface exploration	INDSTRL
5	Data supplied by consulting engineer	ENGINER
6	Data supplied by government agency other than Water Resources	GVTAGCY
7	Data supplied by driller	DRILLER
9	Other	OTHER

UTM LOCATION

AR10
21

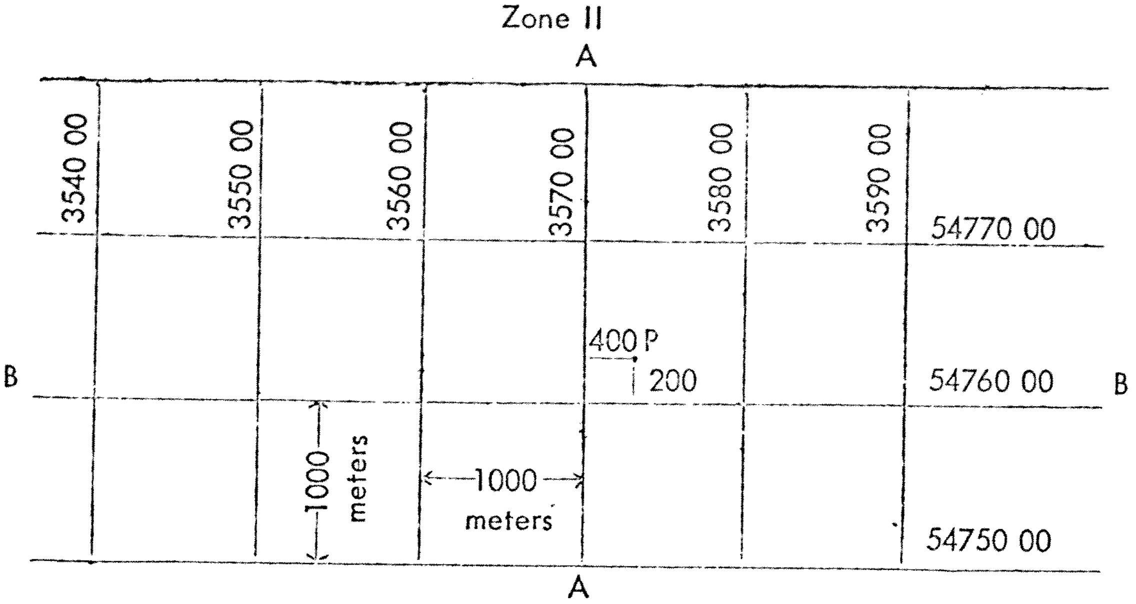
The Universal Transverse Mercator (UTM) grid is a world-wide system of rectangular zones, each 6° longitude wide extending from the equator to the 80th parallel of latitude, north and south. Besides being a unique international system of expressing geographical location, it is readily adaptable to use with computer-oriented X-Y plotters.

The UTM grid is a series of blue or purple squares printed on the National Topographic System standard series maps at scales of 1:250,000, 1:50,000, and 1:25,000. The northing and easting grid lines form the squares, and where they intersect they form a "grid coordinate." The location of a point on the map, therefore, is identified by its "grid coordinates." The "grid coordinates" of a point comprise three elements:

1. the UTM zone number within which the point is located
2. the number of meters from the left boundary of the zone within which it is located (its easting metric value)
3. the number of meters it is located from the equator (its northing metric value).

The location of a point in this system may be expressed to the nearest meter as a fifteen-digit number. The first two digits represent the zone number; the next six digits represent the number of meters from the left boundary of the zone in which the point is located (easting), and the last seven digits represent the number of meters from the equator (northing).

The following illustration demonstrates how a UTM grid coordinate is read.



To read and record the UTM grid coordinate of point "P", it is necessary to note the distance in meters at map scale, between the point "P" and the nearest grid lines to the west and south. This is accomplished by means of a small plastic "romer." The zero coordinate point on the romer is placed on point "P" and the distances, in meters, to the nearest grid lines is read directly from the romer. The "easting" of point "P" is the value of the grid line just west of it plus its distance east of the line. The grid value of line A-A is 357,000E. Thus, the easting of "P" is 357,400. The "northing" of point "P" is the value of the grid line just south of it plus its distance north of that line. The grid value of line B-B is 5,476,000N., and the northing of "P" is 5,476,200. The grid coordinate of point "P" is

Zone II
E = 357,400
N = 5,476,200

The zone number, which is usually printed in the southwest corner of the map-sheet, is entered in boxes 21-22. The easting value is entered in boxes 23-28, and the northing entered in boxes 29-35.

OWNER OR NAME

$\frac{\text{AR10}}{36}$

"Owner" refers to the legal owner of the property on which the well is located or to the person or company holding a long-term lease on the land. "Name" may be used for a well that has been identified locally by a name for a number of years, i.e. "the Hospital well." "Name" may also be used to identify a well drilled as part of a test-drilling program, i.e. "RCA128." If the owner is unknown, this fact should be indicated on the well schedule.

Space is provided on the schedule to record the name and address of the owner. In addition, 12 spaces are provided on the punch card for the owner's name. The name should be printed in the boxes (for columns 36-47) on the schedule, beginning with box 36.

OWNERSHIP

$\frac{\text{AR10}}{43}$

The ownership category should be circled on the schedule and the appropriate code as shown belwo be entered in box 48. For this purpose "city" includes town or village. Churches and other nonprofit, nongovernment groups should be listed in the "corporation or company" category. "Private" refers to individual or family ownership, or the estate of an individual. If the owner is unknown, the code box for column 48 should be left blank.

Code		Mnemonic
1	Federal	FEDERAL
2	Provincial	PRVINCL
3	City	CITY
4	Corporation or company	CORPORT
5	Private	PRIVATE
6	Irrigation district	IRRDIST
7	Research Council of Alberta	RSCHCNL
9	Other	OTHER

USE OF WATER

AR10
49

The purpose for which water from the well is used should be circled on the schedule and the appropriate code designation entered in the box for column 49. Note that only the use of water is shown on this line and that the use of the well will be shown on the next line of the schedule. If the water is used for more than one purpose, the principal use should be shown. If the use of the water is unknown, this should be noted on the schedule and box 49 left blank. Water-use codes are:

Code		Mnemonic
1	Public supply	PUBLIC
2	Commercial-industrial	COMMRCL
3	Domestic	DOMSTIC
4	Irrigation	IRRIGTN
5	Stock	STOCK
6	Recharge	RECHRGE
7	Waste	WASTE
8	Unused	UNUSED
9	Other	OTHER

Public supply use is water that is pumped and distributed to several homes. Such supplies may be owned by a municipality or community, a water district, or a private concern. In Alberta public supplies are regulated by the Department of Health which enforces minimum safety and sanitary requirements. If the system supplies five or more homes, it should be considered a public supply; for four or less it should be considered as domestic. Water supplies for trailer or summer camps with five or more living units should be in this category, but motels and hotels are classified as commercial-industrial.

Commercial-industrial use refers to water that is used by business, manufacturing, and institutional establishments for purposes directly connected with their operation.

Domestic use is water used to supply household needs, principally for drinking, cooking, washing, and sanitary purposes. Most domestic wells will be located at suburban or farm homes but wells supplying small quantities of water for domestic purposes for one-classroom schools and similar installation should be in this category.

Irrigation refers to the use of water to irrigate cultivated plants. Most irrigation wells will supply water for farm crops, but the category should include wells used to water the grounds of schools, industrial plants, or cemetaries if more than a small amount of water is pumped and that is the sole use of the water.

Stock supply refers to the watering of livestock.

Recharge refers to the use of water by oil companies to repressure a producing formation for the purposes of secondary recovery of oil.

Waste refers to water that is not produced for an "economic" purpose. This category includes water that is pumped from a well during a pumping test, uncontrolled flowing wells, and springs.

Unused means water is not being pumped from the well for one of the purposes described above. A test hole, oil or gas well, observation well, or water-disposal well will be in this category.

USE OF WELL

AR10
50

The principal use of the well, or the main purpose for which the hole was drilled, should be circled on the schedule and the appropriate code entered in box 50. The categories shown below should not be confused with those for use of water. If the use of the well is unknown, box 50 should be left blank. If the well has not been put into use when inventoried, show the intended use, such as withdraw or recharge, rather than unused. Codes are:

Code		Mnemonic
1	Withdraw	WITHDRW
2	Test	TEST
3	Observation	OBSRVTN
4	Oil or gas	OILGAS
5	Seismic	SEISMIC
6	Recharge	RECHRGE
7	Destroyed	DESTRYD
8	Unused	UNUSED
9	Other	OTHER

Withdraw is a well that supplies water for one of the purposes shown under use of water.

Test hole is an uncased hole (or one cased only temporarily) that was drilled for water, or for geologic or hydrogeologic testing. It may be equipped temporarily with a pump in order to make a pumping test, but if the well is destroyed after testing is completed, it is still a test hole. A core hole drilled as a part of mining or quarrying exploration work, which is geologic, should be in this class.

Observation well is a cased test hole or well drilled for observations, either water-level or quality of water. Do not use this category for an oil-test hole, or water-supply well used only incidentally as an observation well.

Oil or gas well is any well or hole drilled in search of or for production of petroleum or gas and includes any oil or gas production well, dry hole, core hole, injection well drilled for secondary recovery of oil, etc. An oil-test hole converted to a water-supply well should be designated as used to withdraw water (1). Holes drilled for seismograph testing should be classified as seismic (5).

Seismic hole is one drilled for seismic exploration. If it has been converted to water supply, it is used to withdraw water. A seismic hole used as an observation well should be in the observation-well category.

Recharge well is one constructed for or converted for use in replenishing the aquifer. An irrigation well used to return water to the aquifer during nonpumping periods is a well for withdrawing water, not a drainage or recharge well. Use this category for wells that are used to return water to the aquifer after use.

Destroyed well is one that is no longer in existence. The casing of most destroyed wells will be pulled, but some may be plugged or filled. Do not use this category for an abandoned well that is merely not in use.

Unused well is an abandoned water-supply well or one for which no use is contemplated. At an abandoned farmstead, a well originally used for domestic purposes may be classed as unused even though it is equipped with a pump. Similarly a stock well, with a pump, may become unused when a pasture or corral is put into cultivation. An irrigation well that is not equipped with a pump nor used because the yield is too low or the water is too mineralized belongs in this class.

ELEVATION OF LAND SURFACE

AR10
51

The elevation of the land surface, with respect to mean sea level, should be recorded in this space. Also record the elevation to the nearest foot in boxes 51-54. Examples:

Elevation	Coded
2,326.35	2326
875.89	0876

ACCURACY OR SOURCE OF ELEVATION

AR10
55

Indicate on the schedule the means by which the elevation was determined and show the accuracy of the elevation determination in box 55 according to the following code. If the altitude has not been determined leave box 55 blank.

Code	
1	Instrument level, accurate to 1 foot
2	Instrument level, accurate to 5 feet
3	Instrument level, accurate to 10 feet
4	From topographic map, accurate to 10 feet
5	From topographic map, accurate to 25 feet
6	From topographic map, accurate to 50 feet
7	From topographic map, accurate to 100 feet
8	Altimeter, accurate to 10 feet
9	Altimeter, accurate to 20 feet

DEPTH OF WELL

AR10
56

Enter in this space the depth of the well, at the time of inventory, to the nearest foot, and enter the depth in the box for columns 56-59. A range in depth from 1 to 9,999 feet is provided by the four boxes. Be sure to use box 59 for feet, 58 for tens of feet, 57 for hundreds, etc.

Example:

Depth of well	Coded
26.3	0026
187.8	0188
1423	1423

The depth of the well is the open depth below land surface at the time of inventory. It does not include that part of the casing that extends above the land surface, nor that part of the well that may have been "backfilled","plugged back", or caved after the well was drilled.

ACCURACY OF WELL DEPTH

AR10
60

Enter in box 60 the code designation which best describes the method used to determine the depth of the well.

CASING LENGTH OR DEPTH TO FIRST PERFORATIONS

AR10
61

The casing length or depth to the first perforations should be recorded to the nearest foot in boxes 61-63. The figure to be reported is the length of the upper section of the well from which water is excluded from the well. For a well finished "open hole", the figure to report is the depth at which the bottom of the casing is set. For a cased well with perforations or screens, the depth to be reported is the depth to the top of the first screen or perforated section. For a dug well wall with previous material the reported figure would be 0 feet.

If the well is cased but the depth of the blank casing, or to the first perforations, is unknown that fact should be recorded on the schedule, and boxes 61-63 left blank.

Casing Type

The kind of material used to case the well should be shown in this space on the schedule. Common types are steel, wrought iron, and galvanized iron. Dug wells may be cased or walled with fieldstone, brick, tile, or other material. The type of casing will not be coded for machine storage.

CASING DIAMETER

$\frac{\text{AR10}}{64}$

The inside diameter of the well, in inches, should be recorded in this space. For drilled cased wells, the diameter to be reported will be the nominal outside diameter of the innermost casing at the surface. If the diameter is unknown or cannot be determined, this should be noted on the schedule and the box for columns 64 and 65 should be left blank.

WELL FINISH

$\frac{\text{AR10}}{66}$

"Well finish" refers to the character and position of the openings that permit water to enter the well. Circle the appropriate finish on the schedule and enter the code number for it in box 66.

WELL FINISH

AR10
66

Code		Mnemonic
1	Perforated	PERFRTD
2	Perforated with gravel wall	PERFGVL
3	Screen	SCREEN
4	Screen with gravel wall	SCRNGVL
5	Sand point	SNDPONT
6	Cribbed	CRIBBED
7	Open hole	OPEN
8	Spring	SPRING
9	Other	OTHER

If the finish is unknown, record this fact in the space for "other" and leave the box for column 66 blank.

Perforated casing is well pipe that has had holes punched or slots cut in it to admit water. Perforations may be cut, drilled, or punched in the casing in the shop or during manufacture. Pipe may be perforated in a well, using commercial "gun perforating" services. Slots may be cut by torch, machine cut in the shop, or even cut in the well. Light-weight galvanized well casing with pressed louver-type openings is perforated casing, not screen.

A gravel-wall well is a drilled or dug well that has a gravel envelope opposite the part through which water enters. Commonly, these wells will be finished either with commercial screen or with torch-slotted or machine-slotted casing. Separate classes are used to distinguish between the two types of openings.

Screen refers to commercial well screen manufactured for the purpose of admitting water to a well. Common types of screen are wire mesh, wrapped trapezoidal wire, and shutter screen.

Sand point is the screened part of a drive point and usually is part of a driven well or may be used to deepen a drilled or dug well.

A cribbed well is usually a dug well in which the walls have been curbed or shored up with open-jointed fieldstone, brick, tile, concrete blocks, wooden cribbing, or other material. A few wells of this type may have gravel walls; however, they should be placed in this category instead of 2 or 4. A dug well that is mostly open hole but has only a few feet of curbing, corrugated pipe, or other shoring to prevent caving should be in this category.

An open hole is cased below the depth of possible surface contamination, slumpage, or into solid rock and finished open hole in the aquifer. A well belongs in this class even if the casing does not actually extend to the geologic unit or zone from which the water is obtained.

Spring - water issuing through a natural opening in such quantity to make a distinct current.

METHOD DRILLED

AR10
67

This item refers to the method used to construct the well. Circle the appropriate method on the schedule and enter the code in box 67. If the method is unknown, this should be noted in the space for "other" and the box left blank.

Code		Mnemonic
1	Air rotary	AIROTRY
2	Bored or augered	BORED
3	Cable tool	CABLE
4	Dug	DUG
5	Driven	DRIVEN
6	Hydraulic rotary	HYDRTRY
7	Reverse rotary	REVRTRY
8	Jetted	JETTED
9	Air-percussion	PRCUSSN

Air-rotary method is one in which a stream of air is used to cool the bit and bring the rock cuttings to the surface.

A bored or augered well is one in which the earth materials are cut and removed from the hole with an auger. The auger may be powered by hand or machinery.

Cable tool refers to a well drilled by the familiar "percussion" or "churn-drill" method whereby a heavy drilling tool is raised and lowered with enough force to pulverize the rock. The rock debris is commonly removed from the hole with a bailer. The California mudscow method is a special variation of the cable-tool method.

Dug wells are excavated by hand tools or power-driven digging equipment, such as clam-shell diggers, back-hoes, or power shovels, that dig and remove the material in one operation. Caissons, Ranney-type collectors, and galleries belong in this classification even though they may have laterals that are driven or jetted.

Driven wells are constructed by driving a length of pipe, usually of small diameter and generally equipped with a sand point, to the desired depth. The wells may be driven by hand or with air hammer or other powered equipment. An essential feature of a driven well is that no earth material is removed as the well is constructed.

The hydraulic-rotary well is constructed by rotating a length of pipe (drill stem) equipped with a bit that cuts or grinds the rocks. Water or drilling mud is pumped down the pipe and carries the cuttings to the surface in the annular space between the pipe and the wall of the hole. Note that separate categories are provided for air-rotary and reverse-rotary.

Reverse rotary is similar to the hydraulic rotary except that the water or drilling mud flows down the annular space between the drill stem and the wall of the hole and the cuttings are pumped out through the drill stem.

Jetted wells are excavated using high-velocity streams of water pumped through a pipe having a restricted opening or "jetting" nozzle. For some types of earth materials a cutting bit is attached to the end of the jetting pipe. The material cut or washed from the hole is carried to the surface in the annular space outside the pipe as by the hydraulic-rotary method. This method is most suitable for construction of small-diameter wells in poorly consolidated material.

An air-percussion drill is a cutting unit which is powered by compressed air and uses a rapid percussion effect, coupled with rotary action, to drill hard rocks. Compressed air also is used to blow the cuttings from the hole. Air-percussion drills are generally used in conjunction with air-rotary drilling rigs.

PUMP-INTAKE SETTING

AR10
68

Enter in this space the depth where the pump intake is set, in feet, and enter the numerals for the setting in box for columns 68-70. Use of three columns allows depths up to 999 feet to be shown on the punch card. It is common practice to add several feet of pipe below the impellers, pump bowls, or piston. If the length of pipe does not exceed the suction lift, the water table can be drawn down during pumping to the level of the intake pipe. Information desired for this item is the maximum depth to which the water level can be drawn down during pumping. If such data are not available for the well, the nearest comparable data should be recorded, for instance, the bottom of the pump bowls. If neither intake setting nor bottom of bowls are available, it is sometimes possible to compute the depth to bottom of bowls if the depth to top of the bowls and the number of bowls used are known. If the well has more than one pump, give the intake setting for the largest. If no usable data on pump intake can be obtained, leave boxes for columns 68-70 blank.

PUMP TYPE

AR10
71

Record in this space the type of pump or other conveyance used to bring the water to the surface and enter the appropriate code in box 71.

Code	
1	Air lift
2	Centrifugal
3	Jet
4	Turbine
5	Piston
6	Rotary
7	Submersible
8	Bucket
9	Other

Air lift is a type of lift in which a jet of air pumped below the water table causes a stream of mixed air and water to issue from the well.

Centrifugal pumps are of two types – horizontal and vertical, which merely refer to the axis about which the impellers rotate. Rotation of the impellers in a closed chamber creates a "suction" which draws the water into the pump. The water is then discharged from the pump, commonly under great pressure, by centrifugal force. Such pumps have maximum practical lift of about 25 feet but can force water to considerable heights above the pump. In some areas centrifugal pumps are placed on platforms a few feet above the water table to minimize the lift.

Jet pumps are mainly used for relatively shallow wells although several companies manufacture a so-called "deep-well" jet. They are nearly always electrically powered and are easily recognized by two pipes extending from the pump into the well. One pipe forces water down the hole under pressure while the other pipe discharges water that has been forced to the surface by the action of the jet. Jet pumps are used principally for small water supplies, such as would be used for a suburban home, farm, or small commercial establishment.

Turbines are of several types and may be either for a deep or shallow well.. A series of impellers, placed below the surface of the water, are rotated by a vertical shaft connected to a power source at the land surface. These impellers "pick up" the water and force it to the surface through the pump column. Such wells are commonly used to pump large amounts of water at high pressure. They are used in large-supply wells for public, industrial, or irrigation supply. Power may be supplied by electric motors; gas, gasoline, steam, or diesel engines; tractors, or some other large-power unit.

Piston pumps are of many types and include the familiar lift and pitcher pumps common in many rural areas. The old "reciprocating" pumps and the deep-well pumps with walking-beam jacks are of the piston type.

Rotary pumps may appear to resemble centrifugal pumps on casual inspection; however, they operate on the principle that direct pressure is created by squeezing the water between specially designed runners. A relatively high vacuum may be created on the intake side so the suction lift is comparable to that for centrifugal pumps.

A submersible pump is a special type of turbine in which an electric motor is connected directly to the impellers and submerged beneath the water. It can be recognized by the presence of insulated electric wire leading into the well and the absence of any pump or power unit at the surface.

Bucket includes the familiar "rope and bucket," chain and bucket lifts, and the small bailer lifted by a rope or chain and pulley.

Other. In this category should be placed any lifting device that does not belong in one of the major categories. Examples are: helical rotor, hydraulic ram, and siphon.

YIELD OF THE WELL

AR10
72

Record in this space the yield of the well, in imperial gallons per minute, rounded to the nearest igpm. If a pumping test has been made, the yield to be recorded is that from the test. If not, use yield data available from the driller, owner, or by personal observation. The data for yield, test period (boxes 76-77), and specific capacity (boxes 78-79) should all be from the same test.

TEST PERIOD

AR10
76

Record in this space the length of time over which a pumping test or yield determination were conducted for a period up to and including 24 hours; the number of hours should be entered in boxes 76-77. For test periods ranging over a longer period of time the prefix "A" should be entered in box 76 and the time in minutes, designated by log cycles should be entered in box 77. The first log cycle should begin at a time of 1 minute and the number entered should be rounded to the nearest log cycle.

Example:

Time of Test	Coded
12 hours	12
24 hours	24
2 days = 2,880 minutes	A3
7 days = 10,080 minutes	A4

SPECIFIC CAPACITY OF THE WELL

AR10
78

Specific capacity of a well is defined as the yield in imperial gallons per minute per foot of drawdown. Enter in boxes 78-79 the specific capacity rounded to the nearest whole number. For values less than "1" put a "-" sign in box 78 and the specific capacity to the nearest tenth in box 78.

Example:

Specific Capacity	Code	Output
10	10	10
5	05	5
0.5	-5	0.5
0.2	-2	0.2

ACCURACY OF YIELD DETERMINATION

AR10
80

Record in box 80 the accuracy with which the yield, and specific capacity were determined.

Code		Mnemonic
1	Yield and drawdown data obtained from RCA-supervised aquifer test	RSCHCNL
2	Yield and drawdown data obtained by RCA personnel during testing of existing well	QUALIFD
3	Yield and drawdown data obtained from Water Resources drillers' reports	DRLRPRT
4	Yield and drawdown data obtained from oil, gas mining, or other company	INDSTRL
5	Yield and drawdown data obtained from consulting engineer	ENGINER
6	Data supplied by other government agency	GVTAGCY
7	Data supplied by driller	DRILLER
8	Data supplied by owner	OWNER
9	Other	OTHER

AR20 - HYDROGEOLOGIC DATA

Information relative to the physiographic units, drainage basin, topographic setting, and descriptive data about the aquifer are recorded in this section. Partial data on the chemical characteristics of the water yielded by the well are also recorded in this section.

PHYSIOGRAPHY

AR20
19

Record in the spaces provided on the schedule the physiographic region, province, subdivision, and section for the well area as shown on H. S. Bostock's "A Provisional Physiographic Map of Canada," Department of Mines and Technical Surveys Report and map 13-1964.

Enter in box 19 the number used to designate the region. In box 20 enter the letter which designates the province and in box 21 and 22 the number designating the subdivision. In box 23 enter the letter for the section. For subdivisions without sections, leave box 23 blank. The codes for the physiographic divisions in Alberta are:

1\. Shield Region
C. Western Churchill Province
01 Kazan Upland Subdivision
08 Athabasca Plain Subdivision

2\. Border Region
D. Cordilleran Province
34 Rocky Mountain Foothills Subdivision

E. Interior Plains Province
07 Great Slave Plain Subdivision
08 Alberta Plateau Subdivision
A. Fort Nelson Lowland Section
B. Peace River Lowland Section

09 Alberta Plain Subdivision
A. Cypress Hills Section

10 Saskatchewan Plain Subdivision

DRAINAGE BASIN

AR20
24

Record in the spaces provided on the schedule the primary drainage basin, drainage basin, and subbasin for the well area as shown on the Department of Northern Affairs and National Resources "Stream Measurement Stations" map.

Enter in box 24 the number designating the primary drainage basin. In boxes 25 and 26 enter the letters designating the drainage basin and subbasin, respectively. Box 27 has been reserved for the user who may wish to further subdivide a subbasin for his own purposes. Box 27 will receive a numeric character only. The basin codes in Alberta area

5. Saskatchewan River
    - A. Oldman River
        - A. Crowsnest River
        - B. Willow Creek
        - C. Little Bow
        - D. Belly River
        - E. St. Mary River
        - F. Manyberries Creek
        - G.
        - J. South Saskatchewan
    - B. Bow River
        - A.
        - B.
        - C. Spray River
        - D. Cascade River
        - E.
        - F. Kananaskis River
        - G. Ghost River
        - H.
        - J. Elbow River
        - K. Fish Creek
        - L. Highwood River
        - M. Crowfoot Creek
        - N. Twelve Mile Creek
    - C. Red Deer River
        - A.
        - B. Little Red Deer River
        - C. Medicine River-Blindman River
        - D.
        - E. Kneehills Creek-Rosebud River
        - F.
        - G. Bullpound Creek
        - H.
        - J. Matzhiwin Creek
        - K. Alkali Creek
    - D. North Saskatchewan River
        - A. Mistaya River
        - B. Clearwater River
        - C.
        - D. Brazeau River
        - E. Wabamun Creek
        - F.
    - E. North Saskatchewan River
        - A. Sturgeon River
        - B.
        - C.
        - D.
        - E. Vermilion River
        - F.
        - G.

F.
  A.
  B.
  C.
  D. Ribstone Creek
  E. Battle River
  F.

G.
  A. Eyehill Creek

6. Churchill River
A. Beaver River
  A.
  B.
  C.
  D.
  F. Waterhen River

7. Mackenzie River
A. Athabasca
  A. Sunwapta River
  B.
  C.
  D.
  E.
  F.
  G. McLeod
  H.

B.
  A. Pembina
  B. Pembina
  C.
  D.
  E.
  F. South Heart River
  G.
  H.
  J. Lesser Slave Lake

C.
  A. La Biche River
  B.
  C.
  D. Clearwater River
  E.

D.
  A. Beaver River
  B.
  C.
  D. Athabasca River

F. Peace River
  C. Beatton River
  D. Kiskatinaw River

G.
  A.
  B.
  C.
  D.
  E. Wapiti River
  F.
  G.
  H. Little Smoky River
  J. Smoky River

H.
  A. Peace River
  B.
  C. Notikewin River
  D. Peace River
  E.
  F. Peace River

J.
  A.
  B.
  C.
  D.
  E.
  F. Boyer River

K.
  A.
  B.
  C.
  D.
  E.
  F.

M.
  B.
  D.

N.
  A.
  B.

O.
  A.
  B.
  C.

P.
  A.
  B.
  C.

Q.
    A.
    C.

10.
  D.
    A.
  C.
    A.

11. Mississippi River
  A. Missouri River
    A. Milk River

TOPOGRAPHIC SETTING OF THE WELL

AR20/28

The topographic setting of the area in which the well is situated should be recorded on the schedule and the appropriate code marked in box 28. The setting refers to intermediate geomorphic features that have some hydrologic significance for the well. The codes are:

Code		Mnemonic
D.	Local depression	DEPRSSN
C.	Stream channel	CHANNEL
E.	Dunes	DUNES
F.	Flat	FLAT
H.	Hilltop	HILLTOP
S.	Hillside	HILLSID
L.	Lake, swamp, marsh	MARSH
T.	Terrace	TERRACE
U.	Undulating	UNDLTNG
V.	Valley flat	VLLYFLT

A local depression is an area that has no external surface drainage. Some depressions, such as those in karst areas, are only a few acres in extent, but others may cover a square mile. Do not use this designation for small "interdune depressions" or those on an undulating surface of glacial drift (use undulating).

Stream channel refers to the bed in which a natural stream of water runs. It is the trench or depression washed or cut into the surface of the earth by the moving water that it periodically or continuously contains. This term includes washes, arroyos, and coulees.

Dunes refer to mounds and ridges of windblown or eolian sand. This term should not be used for an isolated mound unless it has a rather extensive area and is of hydrologic significance to the well.

A flat may be part of a larger feature such as an upland flat, mesa or plateau, coastal plain, or pediment. Terraces and valley flats, which are special varieties of flat surfaces, are classified separately.

A hilltop is the upper part of a hill or ridge above a well-defined break in slope. A well on the crest of an escarpment or top of a cuesta slope should be in this category. Use this category for hills of significant height (such as drumlins) above a generally flat area, but not for small "swells" a few feet high on an undulating surface such as a till plain or valley flat.

A hillside is the sloping side of a hill – that is, the area between a hilltop and valley flat. The important factor is the general aspect of the well site. The steepness of the slope or height of the hill are not significant.

Lake refers to a body of inland water. However, this code also may be used for swampy and marshy areas where the ground may be saturated or water may stand above the land surface for a period of time.

An alluvial or marine terrace is generally a flat surface, usually parallel but elevated above a stream valley or coast line. Characteristically, the terrace is separated from an adjacent upland on one side and a lowland (coast or valley) on the other by steep slopes or escarpments. Due to the effects of erosion the terrace surface may not be as smooth as a valley flat and within the general terrace area there may be undulating areas of dune sand or hill slopes.

Undulating topography is characteristic of dune or till areas which have many small depressions and low mounds. An undulating surface is primarily a depositional feature, not an erosional one. The term should not be misused for areas that have slightly irregular surfaces resulting from erosion.

A valley flat is a low flat area between valley walls and bordering a stream channel. It includes the flood plain and lowest alluvial terraces and generally is the flattest area in the valley. The surface may have a slight slope toward the main stream, toward the valley walls, or may be marked by valleys of smaller streams. Generally the valley flat is separated from higher alluvial terraces or from the upland by a pronounced break in slope. Sometimes, however, the erosion of adjacent upland and the deposition of colluvium may mask the outer edge of the alluvial flat. Use for wells in small valleys on a plain or terrace if the well taps alluvium or the valley situation has hydrologic significance.

SURFICIAL MATERIAL

AR20
29

The character of the surficial material will affect the rate of infiltration or recharge (or contamination) near the well site and may have an important bearing on the reliability or permanence of the well. Record here the lithology of the surficial material around the well site and enter an adjective in box 29 and the appropriate rock type in box 30.

Lithology Adjectives

AR20
29

Code		Mnemonic
1	Very fine grained	VFIGRND
2	Fine grained	FINGRND
3	Medium grained	MEDGRND
4	Coarse grained	CRSGRND
5	Very coarse grained	VCRGRND
6	Clayey	CLAYEY
7	Silty	SILTY
8	Sandy	SANDY
9	Gravelly	GRVELLY
A	Argillaceous	ARGLCUS
B	Bentonitic	BENTITC
C	Calcareous	CALCRUS
D	Dune	DUNE
E	Alluvial	ALUVIAL
F	Fractured or jointed	FRACTRD
G	Glacial	GLACIAL
H	Hard	HARD
J	Carbonaceous	CARB
K	Coaly	COALY
L	Laminated	LAMINTD
M	Sandstone stringers	SS STRG
N	Shale stringers	SH STRG
P	Porous	POROUS
Q	Quartzitic	QRTZITC
R	Interbedded	INERBED
S	Soft	SOFT
T	Salt and pepper	SLTPEPR
U	Unconsolidated	UNCNSLD
V	Dense	DENSE
W	Water	WATER
X	Well sorted	WELSRTD
Y	Poorly sorted	PRLYSRT
Z	Weathered	WETHERD

Code	Lithology	Mnemonic
1	Igneous	IGNEOUS
2	Metamorphic	MTMRPHC
3	Sedimentary	SEDMNTR
4	Volcanic	VOLCNIC
5	Boulders	BOULDRS
6	Quartzite	QUARZIT
7	Clay and boulders	CL+BDRS
8	Topsoil	TOPSOIL
9	Claystone	CLYSTON
A	Alluvium	ALLUVUM
B	Bedrock	BEDROCK
C	Conglomerate	CGLMRAT
D	Dolomite	DOLOMIT
E	Drift	DRIFT
F	Shale	SHALE
G	Gravel	GRAVEL
H	Gypsum	GYPSUM
J	Marl	MARL
K	Coal	COAL
L	Limestone	LIMESTN
M	Bentonite	BENTNIT
N	Breccia	BRECCIA
P	Clay	CLAY
Q	Silt	SILT
R	Sand and gravel	SND-GVL
S	Sand	SAND
T	Till	TILL
U	Tuff	TUFF
V	Sandstone	SNDSTON
W	Siltstone	SLTSTON
X	Sandstone and shale	SS SHAL
Y	Rock	ROCK
Z	No sample	NO SMPL

INFILTRATION CHARACTERISTICS

$\frac{AR20}{31}$

Record in this space the relative potential of the surficial material to allow infiltration. This should be reported for the general area of the well, not just the immediate well site. Use judgment and your knowledge of the surficial geology to indicate this characteristic. Enter the appropriate code in box 31.

Code		Mnemonic
1	Excellent	EXCELNT
2	Good	GOOD
3	Fair	FAIR
4	Poor	POOR
5	Very poor	VRYPOOR

GEOLOGICAL SYSTEM

$\frac{AR20}{32}$

The geologic system for the formation or deposit should be recorded on the schedule and marked in box 32 according to the following code:

Code		Mnemonic
Q	Quaternary	QATRNRY
T	Tertiary	TERTIRY
K	Cretaceous	CRETCUS
J	Jurassic	JURSSIC
R	Triassic	TRISSIC
P	Permian	PERMIAN
N	Pennsylvanian	PNSLVAN
M	Mississippian	MISISIP
D	Devonian	DEVONIN
S	Silurian	SILURIN
O	Ordovician	ORDVICN
C	Cambrian	CAMBRIN
Z	Precambrian	PRCAMBR
U	Unclassified	UNCLSIF

If the system is unclassified or unknown, insert "U" in the appropriate box.

AR20
33

GEOLOGICAL SERIES

The series designation for the formation should be recorded on the schedule and the appropriate code entered in box 33.

Code		Mnemonic
R	Recent	RECENT
G	Pleistocene	PLESCEN
P	Pliocene	PLIOCEN
M	Miocene	MIOCEN
O	Oligocene	OLGOCEN
E	Eocene	EOCENE
L	Paleocene	PALEOCN
U	Unclassified	UNCLSIF
3	Upper	UPPER
2	Middle	MIDDLE
1	Lower	LOWER

If the series is unclassified or unknown, insert "U" in the box.

AR20
34

FORMATION OR GROUP

Code		Mnemonic
01	Upper Devonian	U DEVON
Mississippian/Permo-Penn.		
02	Banff	BANFF
03	Exshaw	EXSHAW
04	Rocky Mountain	RKY MTN
05	Rundle	RUNDLE
Triassic		
06	Spray River	SPRAY R
Jurrassic		
07	Fernie	FERNIE
08	Kootenay	KOOTENY
09	Nikanassin	NIKANSN
Lower Cretaceous		
10	Blairmore	BLAIR
11	Bow Island	BOW I
96	Cadotte	CADOTTE
12	Clearwater	CLEAR

Code		Mnemonic
13	Colony	COLONY
14	Colorado	COLORDO
15	Deville	DEVILLE
16	Ellerslie	ELLERSL
17	Gething	GETHING
18	Grande Rapids	GR RPDS
19	Harmon	HARMON
20	Jolifou	JOLIFOU
21	LaBiche	LABICHE
22	Loon River	LOON R
23	Mannville	MANVILE
24	McMurray	MCMURRY
25	Paddy	PADDY
26	Peace River	P RIVER
27	Pelican	PELICAN
28	Shaftesbury	SHFTSBR
29	Sparky	SPARKY
30	Viking	VIKING
31	Wabiskaw	WABISKW

Code		Mnemonic
Upper Cretaceous		
33	Bad Heart	BDHEART
34	Bassano	BASSANO
35	Battle	BATTLE
36	Bearpaw	BEARPAW
37	Belly River	BELLY R
38	Birch Lake, Lower	L BIRCH
39	Birch Lake, Upper	U BIRCH
40	Blackstone	BLKSTON
41	Blood Reserve	BLOOD R
42	Brazeau	BRAZEAU
43	Brosseau	BROSEAU
97	Bulwark	BULWARK
44	Cardium	CARDIUM
45	Chinook	CHINOOK
46	Doe Creek	DOE CRK
47	Dunvegan	DUNVEGN
48	Eastend	EASTEND
49	Edmonton	EDM
50	Edmonton A	EDM A
51	Edmonton B	EDM B
52	Edmonton C	EDM C
53	Edmonton D	EDM D
54	Edmonton E	EDM E
55	Foremost	FORMOST
56	Frenchman	FRNCHMN
57	Grizzly Bear	G BEAR
58	Howard Creek	HOWARD
59	Jumping Pound	J POUND
60	Kaskapau	KASKAPU
61	Kipp	KIPP
62	Lea Park	L PARK
63	Magrath	MAGRATH
64	Medicine Hat	MED HAT
65	Milk River, Lower	L MILK
66	Milk River, Upper	U MILK
67	Mulga	MULGA
68	Muskiki	MUSKIKI
69	Oldman	OLDMAN
70	Pakowki	PAKOWKI
71	Pouce Coupe	P COUPE
72	Puskwaskau	PUSKWAS
73	Ribstone Creek	RIBSTON
74	St. Mary River	ST. MARY
75	Saunders	SAUNDER
76	Shandro	SHANDRO
77	Soloman	SOLOMAN
78	Vanesti	VANESTI
79	Victoria	VICTORI
80	Wapiabi	WAPIABI
81	Wapiti	WAPITI
82	Whitemud	WHITMUD
83	Willow Creek	WILLOW
Tertiary and Younger		
84	Paskapoo	PASKAPO
85	Porcupine Hills	PORCUPN
86	Ravenscrag	RAVSCRG
87	Saskatchewan Gravels & Sand	SASKGVL
88	Cypress Hills	CYPRESS
89	Hand Hills	HANDHIL
90	Alluvium	ALLUVIM
91	Glacial till	GLACTIL
92	Outwash	OUTWASH
93	Terrace deposit	TERRACE
94	Sand and gravel	SNDGRVL
95	Sand	SAND

LITHOLOGY

$\frac{\text{AR20}}{36}$

Generally the lithology of the bedrock formation will be readily ascertainable from knowledge of local geology, from drillers' logs, or well cuttings. Record the lithology of the formation or deposit on the schedule and enter the appropriate code in the box for columns 36 and 37. Use the codes for lithology of surficial material (p. 35). Put adjectives in box 36 and type of rock in box 37.

ORIGIN

$\frac{\text{AR20}}{38}$

Origin refers to the principal geological processes that created the aquifer, formation, or deposits in question. Indicate the origin of the formation on the schedule and enter the appropriate code in the box. If the origin of the formation or deposit is unknown or undetermined, leave the column and box blank.

Code		Mnemonic
1	Glacial	GLACIAL
2	Fluvial (includes channel, flood plain, natural levee, etc.)	FLUVIAL
3	Glaciofluvial	GLAVLUV
4	Deltaic	DELTAIC
5	Eolian (loess, dune sand)	EOLIAN
6	Lacustrine (includes glacial and fresh water lake deposits, swamp and bog deposits	LCUSTRN
7	Marine (stratified sedimentary, estuarine)	MARINE
8	In situ weathering	INSITU

DEPTH TO TOP OF BEDROCK

$\frac{\text{AR20}}{39}$

Enter in this space and in the box for columns 39-41 the depth in feet to the top of the uppermost bedrock formation. This depth provides information concerning the thickness of the unconsolidated and semiconsolidated deposits (i.e. glacial drift or alluvium) at the well site.

If the well does not extend deep enough to reach consolidated rock, or if the depth is not known or cannot be estimated, the box should be left blank.

SOURCE OF DATA

AR20
42

On the same line as "Depth to top of bedrock" record the source from which information on the depth was obtained and enter the appropriate code in box 42.

1	Well cuttings or sample log
2	Electric or other log
3	Drillers' log
4	Oil-well data or logs
5	Seismic or resistivity survey
6	Estimated from surface geology
7	Subsurface map
8	
9	

FLOW SYSTEM

AR20
43

Record in this space and enter in box 43 the code which best describes the nature of the groundwater flow system in which the well is located.

AQUIFER

AR20
44,46,48

The formation, group, aquifer, or informal term for the aquifer should be reported on the schedule. The codes used to describe the uppermost bedrock formation will be entered in the appropriate boxes. The codes for geological system and series (p. 38 and 39) are to be entered in boxes 44-45. The two-digit numerical code for formation or group (p. 39) is entered in boxes 46-47, and the appropriate lithologic description of the aquifer (p. 35) is to be entered in boxes 48-49. Put adjectives in box 48 and rock type in box 49.

ORIGIN OF AQUIFER

AR20
50

Use the codes for "origin of bedrock" (p. 41) which best describes the geological process that created the aquifer. Insert the appropriate code in box 50.

AQUIFER THICKNESS

AR20
51

Enter in this space on the schedule and record in the box for columns 51-53 the total thickness, in feet, of water-bearing zones penetrated by the well, open to it, and contributing water to the well.

LENGTH OF WELL OPEN TO AQUIFER

AR20
54

Enter in this space and record in the box for columns 54-56 the total length, in feet, of the perforated or screened intervals or the length of open hole through which water enters the well. If a well is screened opposite several strata, the figure to be reported is the combined thicknesses that are screened or perforated.

DEPTH TO TOP OF AQUIFER

AR20
57

Enter in this space the depth, in feet, to the top of the aquifer. The top of the aquifer is defined as the top of the first stratum or zone that contributes water to the well. This is not necessarily the same as the stratigraphic top of the geologic unit that contains the aquifer. For a water-table well enter the depth to water.

TYPE OF AQUIFER

AR20
60

Enter in this box the code which best describes the type of aquifer penetrated by the well. In this case water table refers to an aquifer whose upper surface is unconfined or open to atmospheric pressure, and artesian refers to an aquifer containing water under sufficient pressure to rise above its zone of saturation.

AR20
60

If the water contributed to the well originates from both a water-table and an artesian aquifer, the type should be designated as <u>ARTESIAN</u> since in a majority of cases this will be the primary source for the water produced. If the type cannot be determined, classify as <u>unknown</u>.

Code		Mnemonic
1	Water-table aquifer	WTRTBLE
2	Artesian aquifer	ARTESIN
3	Unknown	UNKNOWN

COEFFICIENT OF TRANSMISSIBILITY

AR21
61

Record in this space the coefficient of transmissibility, in gpd/ft. To show T in the box for columns 61-63, report two significant figures in columns in 61 and 62, and the power of 10 in column 63.

Examples:

T	Sig.Figs.	Power of 10	Code
80	80	1	801
750	75	2	752
4,560	46	3	463
43,800	44	4	444
324,000	32	5	325
823,300	82	5	825

COEFFICIENT OF STORAGE

AR20
64

Record in this space the coefficient of storage. To enter its value in the box for columns 64-66 record two significant figures in columns 64-65 and the negative power of 10 in box 66.

Coeff. Storage	Sig.Figs.	Power of 10	Code
.35	35	-1	351
.08	50	-2	502
.015	15	-2	152
.0022	22	-3	223
.0005	50	-4	504

WATER LEVEL ABOVE OR BELOW LAND SURFACE

$\frac{\text{AR20}}{67}$

Record directly in boxes 67-70 the water level with respect to land surface (LS). This will be the water level measured from the RP corrected for the distance between the RP and land surface. For coding the water level should be rounded to the nearest foot. If the well is flowing but the height or pressure is unknown, enter a "-" in box 67 and "1" in box 70. If the head has been determined, enter the numberals for the head, in feet, and put a "-" in box 67.

Examples:

	Coded
W/L measured 175.36 feet	0175
Flows, head unknown	-001
Flows, head 36.3 feet	-036

ACCURACY OF THE WATER LEVEL

$\frac{\text{AR20}}{71}$

The accuracy of the water level recorded on the schedule and shown on the punch card should be indicated in box 71 according to the following code:

1	Tape measurement
2	Air line
3	From drillers' log
4	From electric or borehole log
5	Estimated
6	Reported
7	Water-stage recorder reading
8	Well pumping or recently pumped
9	Nearby well pumping or recently pumped

DATE MEASURED

AR20
72

Show in this space on the schedule the day, month, and year of the water-level measurement recorded on the line above, enter in box 72 the month of the measurement, and in boxes 73-74 the last two digits for the year.

1	January	7	July
2	February	8	August
3	March	9	September
4	April	0	October
5	May	N	November
6	June	D	December

QUALITY OF WATER

Space is provided on the schedule to record the chemical characteristics of the water as reported on the Department of Agriculture Drillers' Reports. Detailed chemical analyses will be reported in the chemical quality-of-water section (AR30).

COLOR

AR20
75

Record in this space and enter the appropriate code in box 75 which best describes the color of the water. If not reported, leave blank. The color codes are:

1	None
2	Brown
3	Red (iron)
4	Yellow (little iron)
5	
6	
7	
8	
9	

ODOR

AR20
76

Record in this space and enter the appropriate code in box 76 which best describes the odor of the water. If not reported, leave blank. The odor codes are:

1	None
2	Rotten eggs
3	
4	
5	
6	
7	
8	
9	

TURBIDITY

AR20
77

Record in this space and enter the appropriate code in box 77 which best describes the turbidity of the water. If not reported, leave blank.

1	Clear
2	Turbid

HARDNESS

AR20
78

Enter in box 78 the code which best describes the hardness of the water from the well. In most cases this information will be obtained from the owner or a driller's report and will reflect a relative hardness only. Where a chemical analysis has been made the hardness will be reported in detail on the AR30 card. The hardness codes are:

Code		Mnemonic
1	Soft – less than 100 ppm	SOFT
2	Medium – 101-500	MEDIUM
3	Hard – More than 500	HARD

SPECIFIC CONDUCTIVITY

AR20
79

The specific conductance of water from the well, expressed as $Kx10^6$, should be recorded on the schedule and the code for the appropriate value entered in the box for column 79.

1	0-100	6	2,001-5,000
2	101-250	7	5,001-10,000
3	251-500	8	10,001-20,000
4	501-1,000	9	More than 20,000
5	1,001-2,000		

FIT FOR HUMAN CONSUMPTION

AR20
80

Enter in box 80 the code which describes whether the water is fit for human consumption.

Code		Mnemonic
1	Fit for human consumption	POTABLE
2	Not fit for human consumption	NOPOTBL

AR30 – CHEMICAL QUALITY-OF-WATER

This section of the schedule is used for recording chemical quality-of-water data. Routine chemical analyses obtained from the Provincial Analyst, commercial laboratories, or by field-testing methods are entered in this section. Because of the procedure used by the Provincial Analyst in determining some of the chemical constituents it is very important that the type of analysis (AR30/25) be indicated on the schedule.

Sub-routines for converting ppm to epm, calculating total anions, cations, the soluble-sodium percentage, S.A.R., Ca/Mg, SO_4/Cl, and percentages of total cations or anions are inherent in the system.

If chemical data is not available, insert a "1" in box 19.

TYPE OF ANALYSIS

$\frac{AR30}{25}$

Record in box 25 the code which best designates the source from which the data required to fill out the AR30 card were obtained. The codes are:

Code		Mnemonic
1	Provincial Analyst	PRVINCL
2	Research Council Laboratory	RSCHCNL
3	Research Council Field Test (Hach kit, etc.)	RCAFILD
4	Commercial Laboratory	COMMRCL
5	Federal Department of Public Health	FEDERAL
6	Petroleum and Natural Gas (source)	OILGAS
7		
8	Provincial Analyst (revised)	PRVINCL
9	Other	OTHER

AR40-AR41 LITHOLOGIC DATA

The information recorded on this part of the schedule describes the lithologic units penetrated by the well. Space is provided to record and code sixteen distinct lithologic units. If more than sixteen units are encountered by the well, it is suggested that the log be condensed at the discretion of the user and a "1" inserted in box 76.

LITHOLOGIC DATA

AR40/19

If no lithologic data is available, insert "1" in box 19.

INTERVAL

AR40/20

Enter directly in boxes 20-22 the depth to the bottom of the lithologic unit being described.

LITHOLOGY

AR40/23

Record in this space the lithologic description of the rock unit. Space is provided to code the major rock type and three adjectives. The lithology codes are:

Code		Mnemonic
1	Igneous	IGNEOUS
2	Metamorphic	MTMRPHC
3	Sedimentary	SEDMNTR
4	Volcanic	VOLCNIC
5	Boulders	BOULDRS
6	Quartzite	QUARZIT
7	Clay and boulders	CL+BDRS
8	Topsoil	TOPSOIL
9	Claystone	CLYSTON
A	Alluvium	ALLUVUM
B	Bedrock	BEDROCK
C	Conglomerate	CGLMRAT

Code		Mnemonic
D	Dolomite	DOLOMIT
E	Drift	DRIFT
F	Shale	SHALE
G	Gravel	GRAVEL
H	Gypsum	GYPSUM
J	Marl	MARL
K	Coal	COAL
L	Limestone	LIMESTN
M	Bentonite	BENTNIT
N	Breccia	BRECCIA
P	Clay	CLAY
Q	Silt	SILT
R	Sand and gravel	SND-GVL
S	Sand	SAND
T	Till	TILL
U	Tuff	TUFF
V	Sandstone	SNDSTON
W	Siltstone	SLTSTON
X	Sandstone and shale	SS SHAL
Y	Rock	ROCK
Z	No sample	NO SMPL

LITHOLOGY ADJECTIVES

Record in boxes 24 and 25 the adjectives which best describe the major rock type. The codes entered in boxes 24 and 25 may be interchanged depending upon the degree of importance as determined by the user. The codes are:

Code		Mnemonic
1	Very fine grained	VFIGRND
2	Fine grained	FINGRND
3	Medium grained	MEDGRND
4	Coarse grained	CRSGRND
5	Very coarse grained	VCRGRND
6	Clayey	CLAYEY
7	Silty	SILTY
8	Sandy	SANDY
9	Gravelly	GRVELLY
A	Argillaceous	ARGLCUS
B	Bentonitic	BENTITC
C	Calcareous	CALCRUS
D	Dune	DUNE
E	Alluvial	ALUVIAL
F	Fractured or jointed	FRACTRD
G	Glacial	GLACIAL
H	Hard	HARD
J	Carbonaceous	CARB
K	Coaly	COALY
L	Laminated	LAMINTD
M	Sandstone stringers	SS STRG
N	Shale stringers	SH STRG
P	Porous	POROUS
Q	Quartzitic	QRTZITC
R	Interbedded	INERBED
S	Soft	SOFT

AR40
24,25

Code		Mnemonic
T	Salt and pepper	SLTPEPR
U	Unconsolidated	UNCNSLD
V	Dense	DENSE
W	Water	WATER
X	Well sorted	WELSRTD
Y	Poorly sorted	POLYSRT
Z	Weathered	WETHERD

COLOR

AR40
26

The following codes are to be used primarily to indicate the color of the sample being described. However, a few selected adjectives describing geologic origin have been included. The codes are:

Code		Mnemonic
1	Eolian	EOLIAN
2	Fluvial	FLUVIAL
3	Lacustrine	LCUSTRN
4	Preglacial	PREGLA
5	Glacial	GLACIAL
6	Postglacial	PSTGLA
7	Saskatchewan	SASK
8	Pebbles	PEBBLES
9	Cobbles	COBBLES
A	Red	RED
B	Red-brown	RED-BRN
C	Yellow	YELLOW
D	Green	GREEN
E	Blue-green	BLU-GRN
F	Blue	BLUE
G	Blue-grey	BLU-GRY
H	Purple	PURPLE

AR40
26

Code	Code		Mnemonic
	J	Red-purple	RED-PRP
	K	White	WHITE
	L	Grey-white	GRY-WHT
	M	Grey	GREY
	N	Grey-brown	GRY-BRN
	P	Grey-black	GRY-BLK
	Q	Grey-green	GRY-GRN
	R	Brown	BROWN
	S	Black	BLACK
	T	Buff	BUFF
	U	Friable	FRIABLE
	V	Gypsiferous	GYPSFRS
	W	Gas	GAS
	X	Flowing	FLOWING
	Y	Blind	BLIND
	Z	Dry	DRY

The lithology coding procedure is to be repeated until the well log has been completely coded. If the description does not extend into section AR41, insert a "1" in box 19. Space has been provided to record depths up to 999 feet; however, provision has been made to code wells which exceed this depth.

Example:

850-900	sandstone, argillaceous, water, grey
900-1,040	shale, sandy, bentonitic, blue

The procedure used in coding this description is as follows:

Interval	Code
900	VAWM
998	
040	F8BF

The "998" entered in the interval column is a computer instruction indicating that successive depths in the interval column are to be added to 1,000.

Comments such as gas, flowing, blind, and dry may be output with the lithologic log by coding 999 in the interval column and the appropriate code in the last box of the lithology code.

Example:

Interval	Code
999	000X

The output from this code will read:

REMARKS	FLOWING

DETAILED LITHOLOGIC LOG

AR41
76

If the lithologic log recorded in this section has been reduced due to space restrictions, or if there is a more detailed log available, insert a "1" in box 76.

ELECTRIC LOG

AR41
77

If an electric log for the well is available insert a "1" in box 77.

OTHER LOGS AVAILABLE

AR41
78

Write on this line of the schedule other types of logs available according to the following code:

1	Drilling-time log (geolograph)
2	Geologist log or sample log
3	Gamma-ray neutron log
4	Sonic log
5	Sieve analysis
6	Permeability determination (lab)
7	
8	
9	

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To: Professional Staff,
Groundwater Division

From: Wm. R. Turner
Date: January 27, 1967.

Subject: INSTRUCTION MANUAL FOR USING THE HYDRODAT COMPUTER-ORIENTED SYSTEM FOR THE STORAGE AND RETRIEVAL OF GROUNDWATER DATA

The attached copy of the subject manual is submitted for your review and comment. The manual provides the codes and instructions necessary for completing the well schedule form. This schedule is the main link between the data collected and the magnetic tape system. Hence, the careful and complete coding of all available data on the schedule form is of great importance to the success of the system.

The manual is still regarded to be in draft form. However, it is considered to be of sufficient importance to distribute in its present form in order that the codes and instructions be made available to Division personnel at this time.

The system is operable at this time and is available to anyone who feels that it may be of use in their respective projects.

I would appreciate your careful review of the manual and your submittal of suggestions for improvements as soon as possible.

Wm. R. Turner

INPUT DATA PREPARATION

This section describes the preparation of control and data cards for processing by the computer. As shown diagrammatically in Figure 4, input to the computer consists of an $IBSYS card, the program object deck, and a data deck. The data deck is made up of:

1 - one lead control card identifying the request.

2 - n data cards, each specifying a criteria to be satisfied.

3 - one end-of-data control card

4 - two output-control cards specifying the information to be retrieved.

N + 4
CARDS

LEAD control card:

Card 1: This card is an 80-character title used to identify the request being processed. The information contained on this card is repeated in the header portion of each page of printer output.

Data cards:

Each data card contains a criteria code specifying a criteria to be satisfied and the maximum and minimum values which limit the range of the data retrieved for that particular criteria.

The maximum and minimum values limiting the criteria must agree with the specified format and be left-justified in columns 20- and 40.

The maximum number of data cards which may be handled by this program is 87. The minimum allowable number is one.

CARD 2: Columns 1-3 contain the criteria code. This value may range from 001 to 087 and is right justified.

Columns 4-19 blank

Column 20 contains the minimum value limiting the criteria

Column 40 contains the maximum value limiting the criteria

(CARD n: Last) - OMIT-

End-of-data control card:

Card n+2: This card contains the characters 099 in columns 1-3

Output -control cards:

The remaining two cards specify the information to be retrieved and presented as printed output. The system has been designed so that the index number will be retrieved and given as output routinely with each request. The system will accept a maximum of 28 specified items for output.

Card n 3: This card contains the character "1" in the desired card columns as specified by the the output-control column number.

Card n 4: Same as card n 3

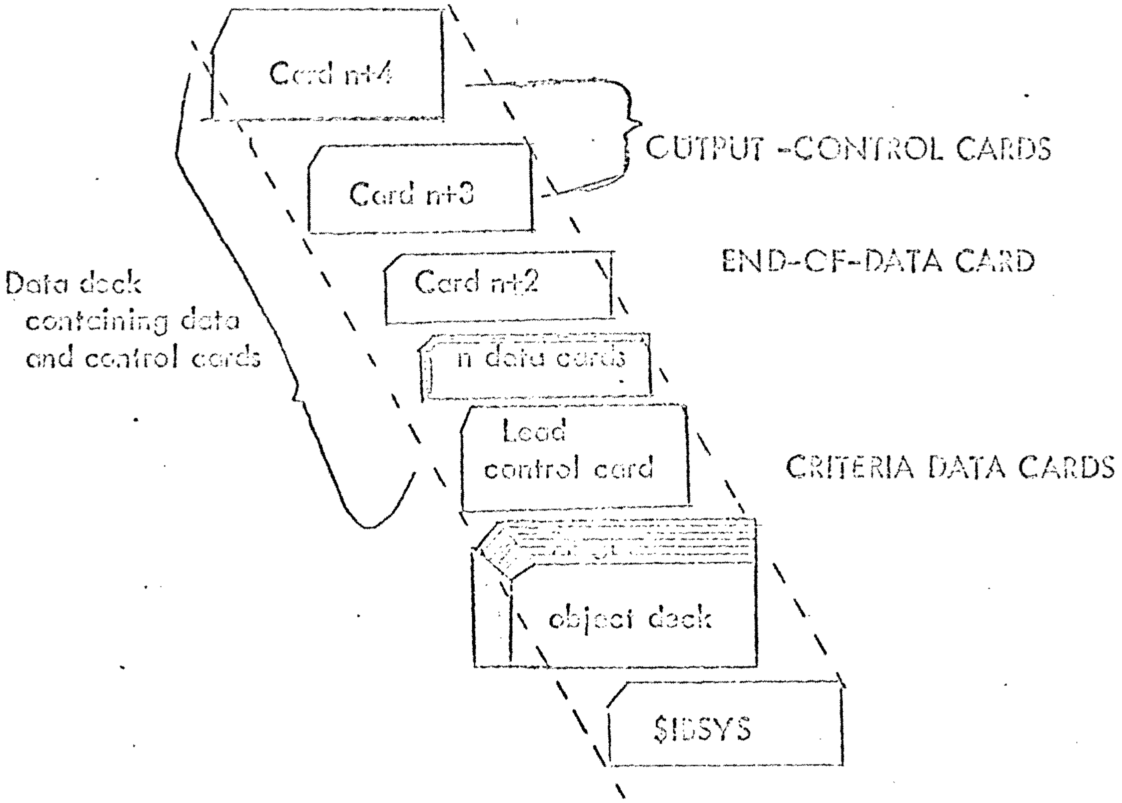

Figure 4, Make-up of HYDRODAT retrieval program package with $IBSYS CARD, program object deck, data, and control cards.

Output control column number	Data	Criteria Code	Format
	Location, Ownership, and Well Description		
Card 1-	Township	001	2I3
	Range	002	2A4
	Section	003	2I2
	Legal subdivision	004	2A2
	Sequential number	005	2F3.1
1	location accuracy	006	2I1
2	Source of data	007	2I1
3	UTM zone	008	2I2
4	easting	009	2I6
5	northing	010.	2I7
6	Owners name (a)		
7	(b)		
8	Ownership	011	2I1
9	Use of water	012	2I1
10	Use of well	013	2I1
11	Elevation of land surface	014	2I4
12	elevation accuracy	015	2I1
13	Depth of well	016	2I4
14	reported or measured	017	2I1
15	Casing length	018	2I3
16	casing diameter	019	2I2
17	Well finish	020	2I1
18.	Method drilled	021	2I1
19	Pump setting	022	2I3
20	pump type and power	023	2I1
21	Well yield	024	2I4
22	test period	025	2A2
23	specific capacity	026	2I2
24	yield accuracy	027	2I1
25			
	HYDROLOGIC INFORMATION		
25	Physiography	028	2A5
26	Drainage basin	029	2A4
27	Topographic setting	030	2A1
28	lithology adjective (Surficial material)	031	2A1
29	lithology	032	2A1
30	infiltration characteristics	033	2I1
31	System (bedrock)	034	2A1
32	series	035	2A1
33	formation or group	036	2I2
34	lithology adjective	037	2A1

Output control number	Data	Criteria code	Format
HYDROLOGIC (cont')			
35	lithology	038	2A1
36	origin	039	2I1
37	depth to bedrock	040	2I3
38	elevation of bedrock	041	2I4
39	source of depth information	042	2I1
40	Flow system	043	2I1
41	flow factor	044	2I5.3
42	Aquifer system	045	2A1
43	series	046	2A1
44	formation ,group ,or aquifer	047	2I2
45	lithology adjective	048	2A1
46	lithology	049	2A1
47	origin	050	2I1
48	aquifer thickness,	051	2I3
49	length of well open to	052	2I3
50	depth to top of	053	2I3
51	elevation of aquifer	054	2I4
52	aquifer classification	055	2I1
	Aquifer characteristics		
53	transmissibility	056	
54	storage coefficient	057	
55	Water level	058	2I4
56	elevation	059	2I4
57	accuracy	060	2I1
58	date measured	061	2A3
59	Quality of water color	062	2I1
60	odor	063	2I1
61	turbidity	064	2I1
62	hardness	065	2I1
63	specific conductivity	066	2I1
64	potability	067	2I1
	CHEMICAL ANALYSIS OF WATER (ppm)		
65	Date sampled	068	2A5
66	Type of analysis	069	2I1
67	Sampling depth	070	2I3
68	Total dissolved solids	071	2I5
69	Ignition loss	072	2I4
70	hardness	073	2I4
71	SO4	074	2I4
72	CL	075	2I4
73	Alkalinity (HCO3+CO3)	076	2I4
74	NO2	077	2F2.1
75q	NO3	078	2F3.1
76	Fe	079	2F2.1

cont'

	number	data	criteria code	format
	77	HCO3	030	2I4
	78	CO3	031	2I3
	79	Ca	032	2F4.1
	80	Mg	033	2F3.1
CARD 2	1	Na +K	034	2I4
	2	F	035	2F2.1

CHEMICAL CONVERSIONS and CALCULATIONS

3*	SO4(epm)
4*	CL(epm)
5*	ALKALINITY, HCO3 + CO3(epm)
6*	HCO3(epm)'=
7*	CO3(epm)
8*	NO3(epm)
9*	Total anions
10*	Ca+Mg(epm)
11*	Ca(epm)
12*	Mg(epm)
13*	Na+K(epm)
14*	Total cations
15*	%Na
16*	SAR, sodium absorption ratio
17*	%Na+K
18*	%SO4
19*	%CL
20*	%Alkalinity, HCO3 + CO3
21*	Ca/Mg
22*	SO4/CL

* denotes a calculation

Lithology*

Depth	036	2I3
Lithology	037	2A1

*refer back to top of page

SAMPLE INPUT DATA

Following is a request for all wells which satisfy the following criteria:
-between Townships 6 and 12
-between ranges 19 and 23W4
-completed in the Belly River formation

Criterion	Criteria Code	Min. Value	Max. Value
Township	001	006	012
Range	002	19W4	23W4
Formation	047	37	37

The desired output for the request is:

Dat output	Output-control card and column number
Owners name	Card 1, Column 6 and 7
Use of water	9
Method drilled	18
Bedrock elevation	35
SO4	71
HCO3	77
Na+K	Card 2, Column 1
Total anions	9
Total cations	14
Ca/Mg	21
SO4/CL	22

Lithologic log- lithology is classified as a criteron and is presented as output when
listed as a satisfying criteron.

Figure 5 illustrates the coding procedure for this request. Do not leave blank lines between statements, this indicates to the key punch operator that a blank card is required.

Appendix

A Computer-Oriented Ground-Water Information Storage and Retrieval System[a]

by Wm. R. Turner[b]

ABSTRACT

The ever-increasing volume of information being collected by the Groundwater Division of the Research Council of Alberta required that a data storage and retrieval system be devised to handle this information in an efficient and economical manner.

The HYDRODAT computer-oriented system developed for this purpose is a modification of the format developed by the United States Geological Survey and conforms to the proposed interagency compatibility requirements set forth by the Canada Department of Energy, Mines and Resources.

The basic elements of the system are: a well-schedule form for the recording and coding of geologic, hydrologic, and water quality data; and five 80-column IBM punch cards for transferring the coded data to magnetic tape.

Selective and rapid retrieval of large volumes of ground-water information using HYDRODAT provides the geologist and engineer with analytical methods which would otherwise be tedious, if not impossible, to apply by conventional methods.

INTRODUCTION

HYDRODAT is a computer-oriented system developed by the Groundwater Division of the Research Council of Alberta for storage, retrieval, and statistical analysis of ground-water information. The system, a modification of that developed by the Water Resources Division of the United States Geological Survey (Lang and Irwin, 1965), conforms to the format proposed by the Canada Department of Energy, Mines and Resources to facilitate the interchange of information among agencies involved in hydrologic studies.

Since its inception in 1957, the Groundwater Division has been primarily concerned with the delineation and evaluation of the ground-water resources of Alberta. Early studies were largely of a detailed nature to resolve specific supply problems, mainly in the more populated regions. As the need for investigations of a more quantitative and regional nature increased, large-scale reconnaissance surveys became necessary, resulting in accumulation of a large volume of information pertaining to the occurrence and distribution of ground water within the provincial boundaries. This large amount of information not only created filing and storage problems but hindered the efforts of geologists and engineers who need to retrieve these data quickly and in a form suitable for their specific purposes. Thus, a need was created for some sort of automated system of data handling.

Various types of information are collected during a ground-water investigation. These data include reported or measured information on well construction and completion, and on water levels, well yields, and subsurface conditions – both geologic and hydrologic. Most data on file come from well inventories made during areal investigations, from drillers' reports filed with the provincial Department of Agriculture, and from chemical analyses of water samples submitted to the Provincial Analyst.

Ground-water studies that will be necessary in the future will require even more detailed investigations than have been made to date, and the quantity and complexity of the data to be synthesized will multiply at an ever-increasing rate. These data – hydrologic, geologic, and chemical – can be collectively described as information, which, when gathered into an organized collection, should be readily accessible to the system user.

SYSTEM DEVELOPMENT

The field of information storage and retrieval is primarily concerned with methods of creating and managing collections of records so as to facilitate rapid and accurate recovery of pertinent information. Ideally, the system user would like to have access to large numbers of potentially useful records, and to have the facility to retrieve selectively from them the particular information pertaining to any specific need.

Information storage and retrieval systems operate as follows:

1. Records are gathered and inserted into a collection in some orderly manner, usually by indexing.

2. The user addresses a question to the collection.

3. On the basis of the question, a search of the collection is conducted and pertinent records are identified and retrieved.

Two extreme approaches exist to designing information, storage, and retrieval systems to satisfy unstated requirements: one is to anticipate potential questions and then to analyze and organize the collection of records with great precision so that the potential questions can be answered quickly and efficiently; the second is to avoid completely any unnecessary prior processing of the records. The first approach can be accomplished by extrapolating from past requirements and trends, and creating a collection based on indexing and cross-indexing. When a question is asked, one would presumably have the pertinent records or their index entries already segregated from the rest of the collection, making retrieval

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rapid and routine. By contrast, in the second approach, when a specific question is received, a record-by-record search of the collection must generally be made. The first approach is practical where needs can be anticipated precisely and where rapid retrieval is essential. Since the user's needs cannot generally be fully anticipated, however, the second approach satisfies the criteria of an "ideal" system. Virtually all systems employ a balance of the two approaches, since some degree of prior organization is desirable to eliminate large portions of the collection from consideration during a search.

The methods used in creating an information storage and retrieval system are illustrated in Figure 1. Basically, the system can be broken down into its two major functions, storage and retrieval. Three steps are involved in each function.

A. Storage

1. Collection of records and identification of those (1, 2, 3, etc.) that contain specific information – for example, chemical quality-of-water data.
2. Analysis of each record to determine whether specific data – such as chloride or iron content – are recorded (A, B, C, etc.).
3. Storage of each individual record in a medium which provides for a method of indexing in code the data contained in each record. In the example (Figure 1) the eight spaces correspond to the letters A-H.

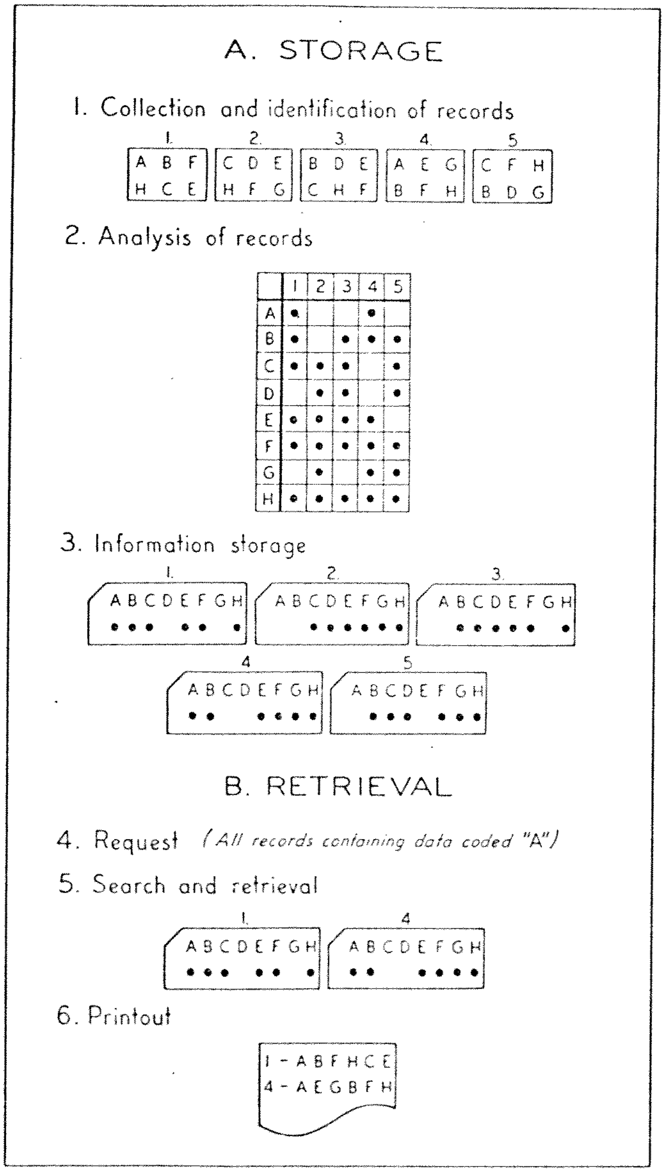


Fig. 1. Methods used in creating an information storage and retrieval system.

B. Retrieval

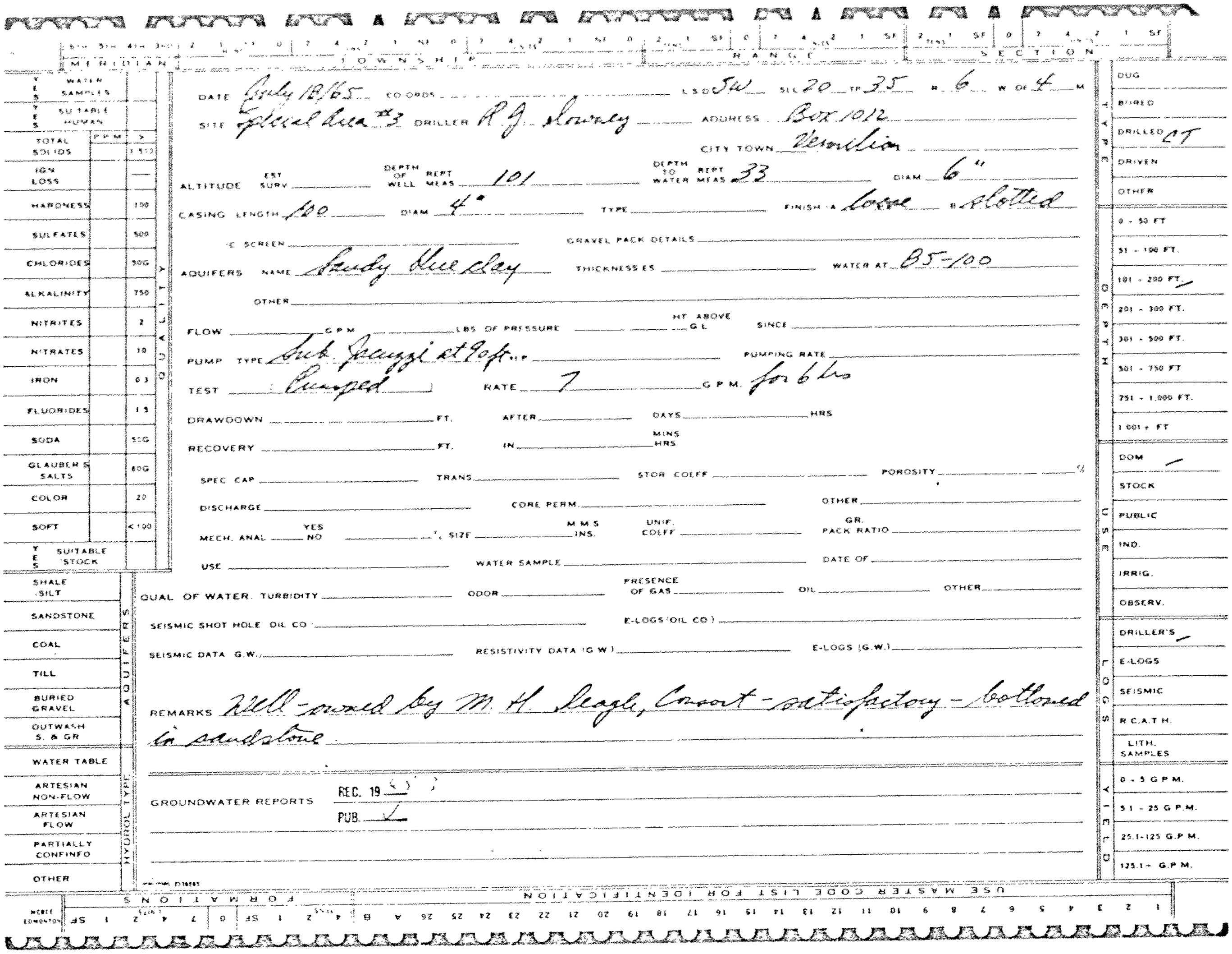
4. Request received for records containing certain data.
5. Search made of the coded index numbers and pertinent records retrieved.
6. Presentation of information.

One approach to the storage and retrieval of ground-water data is the system initiated by the Groundwater Division in 1960. Figure 2 shows one of the hand-sorted, edge-punched cards used to record the standard information obtained during well inventories and from drillers' reports. Space is provided on the back of the card to record additional information. Indexing is achieved by punching the appropriate codes along the edge of the card. Data for approximately 20,000 wells are at present filed in this system and these data do not include the bulk of the available information on water quality. As these data accumulated, it soon became obvious that a more rapid machine-oriented method for storage and retrieval was a necessity.

The storage and retrieval functions described so far all involve the manipulation of digital information or of information that can be transcribed into digital form. Data of this type can be handled by machines provided that the basic records are available in a machine-readable form such as punched cards or magnetic tape. However, whether the data are machine-readable or not, some kind of typed or handwritten record is always essential.

In the case of the hand-sorted, edge-punched card system described above, the final data storage is on the typed or handwritten record; in the case of machine handling, this record is only a preliminary step prior to storage on cards or magnetic tape. Hence, some additional manipulation is required in preparing data for machine storage. Furthermore, since the data must be presented to the machine in suitable form, extra care is required in their preparation. However, the advantages to be gained from machine selection and retrieval of data far outweigh the disadvantages associated with preparation for machine storage.

In 1966 a pilot study was conducted by the Groundwater Division to evaluate the applications of electronic data-processing techniques to information storage and to user oriented retrieval methods. The following discussion describes the HYDRODAT system which evolved from this study.



MERIDIAN TOWNSHIP RANGE SECTION

DATE July 18/65 CO ORDS L.S.D. SW SEC 20 TP 35 R 6 W OF 4 M

SITE Special Area #3 DRILLER R. J. Lowrey ADDRESS Box 1012

CITY TOWN Vermilion

ALTITUDE EST SURV DEPTH OF WELL REPT MEAS 101 DEPTH TO WATER REPT MEAS 33 DIAM 6"

CASING LENGTH 100 DIAM 4" TYPE FINISH A Loose B slotted

C SCREEN GRAVEL PACK DETAILS

AQUIFERS NAME Sandy blue clay THICKNESSES WATER AT 85-100

OTHER

FLOW G.P.M. LBS OF PRESSURE HT ABOVE G.L. SINCE

PUMP TYPE Sub. Jacuzzi at 90 ft. H.P. PUMPING RATE

TEST Pumped RATE 7 G.P.M. for 6 hrs

DRAWDOWN FT. AFTER DAYS HRS

RECOVERY FT. IN MINS HRS

SPEC CAP TRANS STOR COEFF POROSITY %

DISCHARGE CORE PERM OTHER

MECH. ANAL YES NO %, SIZE M.M.S. INS. UNIF. COEFF GR. PACK RATIO

USE WATER SAMPLE DATE OF

QUAL. OF WATER. TURBIDITY ODOR PRESENCE OF GAS OIL OTHER

SEISMIC SHOT HOLE OIL CO E-LOGS (OIL CO)

SEISMIC DATA G.W. RESISTIVITY DATA (G.W.) E-LOGS (G.W.)

REMARKS Well-owned by M. H. Seagle, Consort - satisfactory - bottomed in sandstone

GROUNDWATER REPORTS REC. 19

PUB. ✓

	PPM	
YES WATER SAMPLES		
YES SUITABLE HUMAN		
TOTAL SOLIDS		1,500
IGN LOSS		—
HARDNESS		100
SULFATES		500
CHLORIDES		50G
ALKALINITY		750
NITRITES		2
NITRATES		10
IRON		0.3
FLUORIDES		1.5
SODA		50G
GLAUBER'S SALTS		60G
COLOR		20
SOFT		<100
YES SUITABLE STOCK		

AQUIFERS: SHALE SILT; SANDSTONE; COAL; TILL; BURIED GRAVEL; OUTWASH S. & GR.

HYDROL TYPE: WATER TABLE; ARTESIAN NON-FLOW; ARTESIAN FLOW; PARTIALLY CONFINED; OTHER

TYPE: DUG; BORED; DRILLED CT; DRIVEN; OTHER

DEPTH: 0 - 50 FT; 51 - 100 FT.; 101 - 200 FT. ✓; 201 - 300 FT.; 301 - 500 FT.; 501 - 750 FT; 751 - 1,000 FT.; 1,001 + FT

USE: DOM ✓; STOCK; PUBLIC; IND.; IRRIG.; OBSERV.

LOGS: DRILLER'S ✓; E-LOGS; SEISMIC; R.C.A.T.H.; LITH. SAMPLES

YIELD: 0 - 5 G.P.M.; 5.1 - 25 G.P.M.; 25.1-125 G.P.M.; 125.1 + G.P.M.

FORMATIONS

USE MASTER CODE LIST FOR IDENTIFICATION

Fig. 2. Hand-sorted, edge-punched data card for recording water well information.

THE HYDRODAT SYSTEM

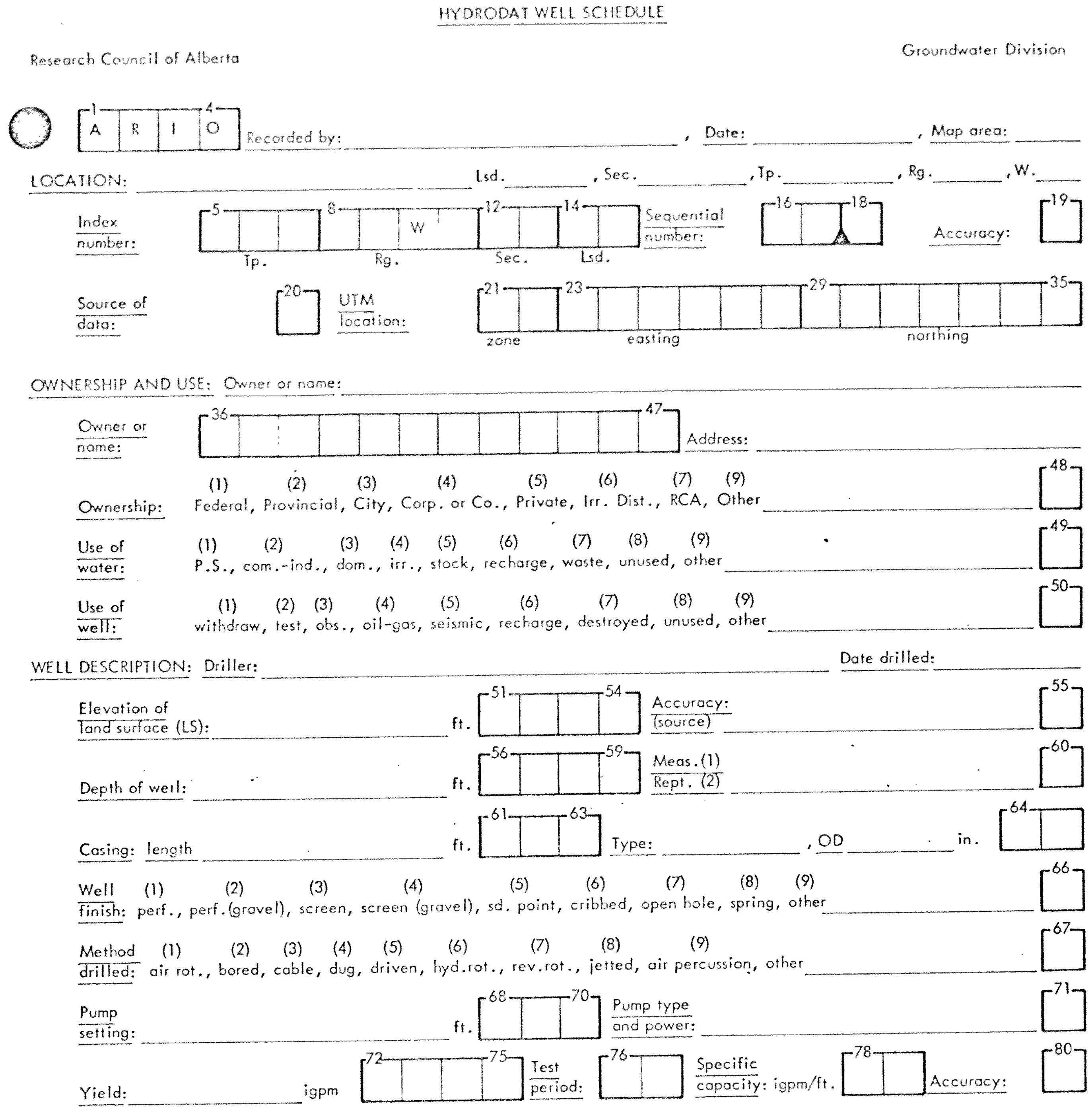
The HYDRODAT system has been designed to meet the proposed compatibility requirements set forth by the Inland Waters Branch of the Canada Department of Energy, Mines and Resources (Gilliland, 1966). Gilliland suggests that participating agencies follow a standard format, so as to allow integration of individual systems. The creation on magnetic tape of master files, containing not the data as such, but only the locations, and types of data available, will allow for the interchange of basic information among participating agencies. These agencies would need only to search the master files to determine where particular information is available. The collecting agency, upon request, would then supply the appropriate data tapes together with an explanation of the file structure and of the sorting and retrieval procedures.

The basic elements of the HYDRODAT system are: a well-schedule form for the recording and coding of data, five 80-column IBM punch cards for transferring the coded data to magnetic tape, and a manual of instructions (Turner, 1967).

Well-Schedule Form

The well-schedule form (Figures 3a, 3b, and 3c) is divided into five sections, each section containing the amount of data required to fill a single punch card. The form is keyed to the punch cards by means of numbered boxes in which numerical data or coded information may be inserted. The numbered boxes on the schedule correspond to the columns of the five cards which comprise the entire system. The data, obtained during field inventory, from drillers' reports, and from chemical quality-of-water analysis, are recorded on the well-schedule in the appropriate numbered boxes.

The data recorded on the first part of the schedule (Figure 3a) locates, identifies, and describes such physical characteristics of the well as elevation, depth, construction, and yield. The function of the index number (boxes 5-18) is twofold: first, it locates the well according to the Dominion Lands System of Survey and secondly, when used in conjunction with the sequential number, gives each well an unique address which identifies the five punch cards belonging to the same observation. The geographical location of the well as expressed by the Universal Transverse Mercator System (UTM) is also entered on the well-schedule form. The "military grid," as it is more commonly known, is used because of its world-wide acceptance and adaptability to computer-oriented X-Y plotters.



HYDRODAT WELL SCHEDULE

Research Council of Alberta

Groundwater Division

○ 1 A R I O 4 Recorded by: ____, Date: ____, Map area: ____

LOCATION: ____ Lsd. ____, Sec. ____, Tp. ____, Rg. ____, W. ____

Index number: 5 Tp. 8 W Rg. 12 Sec. 14 Lsd. Sequential number: 16 18 Accuracy: 19

Source of data: 20 UTM location: 21 zone 23 easting 29 northing 35

OWNERSHIP AND USE: Owner or name: ____

Owner or name: 36 47 Address: ____

Ownership: (1) Federal, (2) Provincial, (3) City, (4) Corp. or Co., (5) Private, (6) Irr. Dist., (7) RCA, (9) Other ____ 48

Use of water: (1) P.S., (2) com.-ind., (3) dom., (4) irr., (5) stock, (6) recharge, (7) waste, (8) unused, (9) other ____ 49

Use of well: (1) withdraw, (2) test, (3) obs., (4) oil-gas, (5) seismic, (6) recharge, (7) destroyed, (8) unused, (9) other ____ 50

WELL DESCRIPTION: Driller: ____ Date drilled: ____

Elevation of land surface (LS): ____ ft. 51 54 Accuracy: (source) ____ 55

Depth of well: ____ ft. 56 59 Meas. (1) Rept. (2) ____ 60

Casing: length ____ ft. 61 63 Type: ____, OD ____ in. 64

Well finish: (1) perf., (2) perf. (gravel), (3) screen, (4) screen (gravel), (5) sd. point, (6) cribbed, (7) open hole, (8) spring, (9) other ____ 66

Method drilled: (1) air rot., (2) bored, (3) cable, (4) dug, (5) driven, (6) hyd.rot., (7) rev.rot., (8) jetted, (9) air percussion, other ____ 67

Pump setting: ____ ft. 68 70 Pump type and power: ____ 71

Yield: ____ igpm 72 75 Test period: 76 Specific capacity: igpm/ft. 78 Accuracy: 80

Fig. 3a. Well-schedule form for location, identification and well description data.

Information relative to the physiographic units, drainage basin and topographic setting, and descriptive data about the aquifer are recorded in the hydrogeologic section (Figure 3b). Partial data on the chemical characteristics of the well water as reported by the driller are recorded in this section also.

The third section shown in Figure 3c is used for recording more comprehensive chemical quality-of-water data. Routine chemical analyses obtained from the Provincial Analyst, commercial laboratories, or by field testing methods are entered in this section.

The last two sections are used to record the lithologic descriptions of the rock units penetrated by the well.

A condensed version of the HYDRODAT well-schedule is available for the storage and analysis of lithologic data obtained from seismic shot holes, structure test holes, and oil and gas wells.

Data Processing

The facilities of the University of Alberta Computing Centre are used for processing the data. Completed well-schedule forms are submitted to the computing centre where keypunch operators transfer the coded information directly from the schedule to punch cards. The coded data are then transferred to magnetic tape and the schedules and punch cards returned to the Groundwater Division for filing.

○ 1 | A | R | 2 | O | 4

5 SAME AS CARD ARIO 18

HYDROGEOLOGIC ENVIRONMENT:

Physiographic region: ____ ☐ 19 Province: ____ ☐ 20

Subdivision: ____ ☐☐ 21 Section: ____ ☐ 23

Primary drainage basin: ____ ☐ 24 Drainage basin: ____ ☐ 25 Subbasin: ____ ☐ 26 ☐ 27

Topographic setting: (D) local depression; (C) stream channel; (E) dunes; (F) flat; (H) hilltop; (S) hillside; (L) lake, swamp, or marsh; (T) terrace; (U) undulating; (V) valley flat ____ ☐ 28

Surficial material: ____ ☐☐ 29 Infiltration characteristics: ____ ☐ 31

Uppermost bedrock fm.: ____ , ____ ☐☐ 32 ____ ☐☐ 34
system series formation or group

Lithology: ____ ☐☐ 36 Origin: ____ ☐ 38

Depth to top of bedrock: ____ ft. ☐☐☐ 39–41 Source: ____ ☐ 42

Area of downward flow (1); Area of upward flow (2); Area of transitional flow (3); Uncertain (4) ____ ☐ 43

AQUIFER:

____ ____ ☐☐ 44 ____ ☐☐ 46
system series member, formation, or group

Lithology: ____ ☐☐ 48 Origin: ____ ☐ 50 Aquifer thickness: ____ ft. ☐☐☐ 51–53

Length of well open to aquifer: ____ ft. ☐☐☐ 54–56 Depth to top of aquifer: ____ ft. ☐☐☐ 57–59

Intervals screened: ____

Water-table aquifer (1), Artesian aquifer (2), Unknown (3) ____ ☐ 60

AQUIFER CHARACTERISTICS:

Coefficient of transmissibility: ____ igpd/ft ☐☐☐ 61–63 Coefficient of storage: ____ ☐☐☐ 64–66

WATER LEVEL: Describe reference point (RP) ____ which is ____ ft. above/below LS

Water level: ____ ft. above/below RP; Water level: ____ ft. above/below LS ☐☐ 67–70 Accuracy: ☐ 71

Date measured: ____ ☐☐☐ 72–74
mon. year

QUALITY OF WATER:

color: ____ ☐ 75 odor: ____ ☐ 76 turbidity: ____ ☐ 77

Hardness: Soft (1), medium (2), hard (3) ____ ☐ 78 Specific conductivity: ____ $\times 10^6$ ☐ 79 Fit for human consumption: yes(1) no (2) ____ ☐ 80

Fig. 3b. Well-schedule form for hydrogeologic data.

1 A | R | 3 | O 4 | 5 SAME AS CARD AR10 18 | no chemical data-insert "1" in box 19 | 19 ☐

CHEMICAL ANALYSIS OF WATER (ppm):

Date sampled: 20–21 mon. ☐ 21–22 day ☐ 23–24 year ☐ | Type analysis: 25 ☐ | Sampling depth: 26–28 ☐ | Total dissolved solids: 29–33 ☐

Ignition loss 34–37 ☐ | Hardness: 38–41 ☐ | SO_4 42–45 ☐ | Cl 46–49 ☐

Alkalinity 50–53 ☐ | NO_2 54 ☐ | NO_3 56–58 ☐ | Fe 59 ☐ | HCO_3 61–64 ☐

CO_3 65–67 ☐ | Ca 68–71 ☐ | Mg 72–74 ☐ | Na+K 75–78 ☐ | F 79 ☐

1 A | R | 4 | 0 4 | 5 SAME AS CARD AR10 18 | If no lithologic data – insert "1" in box 19 | 19 ☐

LITHOLOGIC LOG:

Interval (feet) | Lithology | Code

____ 20–22 ☐ ____ , ____ , ____ , ____ 23–26 ☐

lithology | adjective | adjective | color

____ 27–29 ☐ ____ , ____ , ____ , ____ 30–33 ☐

____ 34–36 ☐ ____ , ____ , ____ , ____ 37–40 ☐

____ 41–43 ☐ ____ , ____ , ____ , ____ 44–47 ☐

____ 48–50 ☐ ____ , ____ , ____ , ____ 51–54 ☐

____ 55–57 ☐ ____ , ____ , ____ , ____ 58–61 ☐

____ 62–64 ☐ ____ , ____ , ____ , ____ 65–68 ☐

____ 69–71 ☐ ____ , ____ , ____ , ____ 72–75 ☐

1 A | R | 4 | 1 4 | 5 SAME AS CARD AR10 18 | If no lithologic data – insert "1" in box 19 | 19 ☐

____ 20–22 ☐ ____ , ____ , ____ , ____ 23–26 ☐

____ 27–29 ☐ ____ , ____ , ____ , ____ 30–33 ☐

____ 34–36 ☐ ____ , ____ , ____ , ____ 37–40 ☐

____ 41–43 ☐ ____ , ____ , ____ , ____ 44–47 ☐

____ 48–50 ☐ ____ , ____ , ____ , ____ 51–54 ☐

____ 55–57 ☐ ____ , ____ , ____ , ____ 58–61 ☐

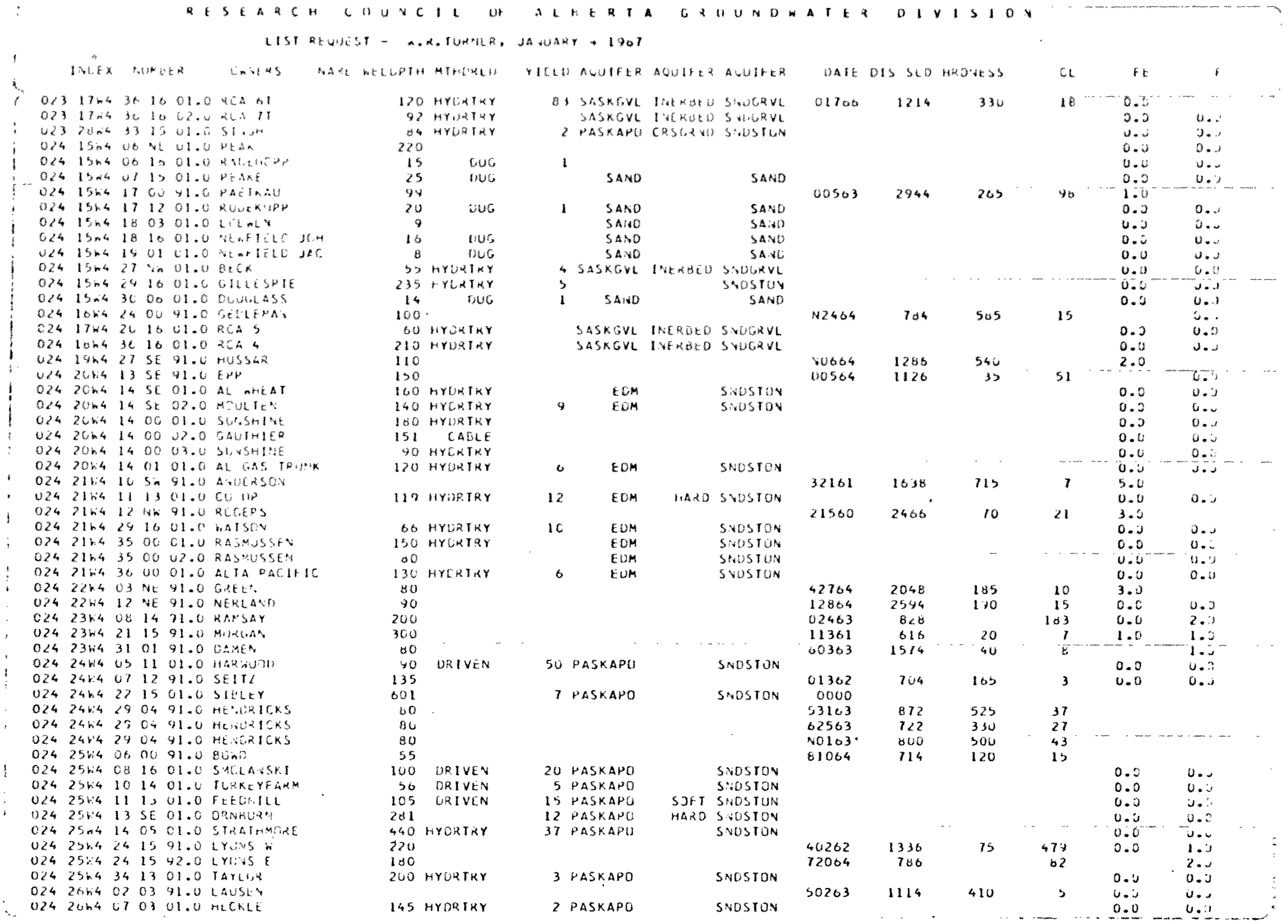
____ 62–64 ☐ ____ , ____ , ____ , ____ 65–68 ☐

____ 69–71 ☐ ____ , ____ , ____ , ____ 72–75 ☐

Additional lithologic data available – insert "1" in appropriate box | Detailed lithologic log 76 ☐ | Electric log 77 ☐ | Other 78 ☐

Keypunch operator ____ Date ____ Verified ____

Fig. 3c. Well-schedule form for chemical quality-of-water and lithologic data.



```
                    R E S E A R C H   C O U N C I L   O F   A L B E R T A   G R O U N D W A T E R   D I V I S I O N

                                 LIST REQUEST -  A.R.TURNER, JANUARY 4 1967

    INDEX  NUMBER     OWNERS     NAME WELLDPTH MTHDRLD   YIELD AQUIFER AQUIFER AQUIFER     DATE DIS SLD HRDNESS        CL         FE        F

 023 17W4 36 16 01.0 RCA 6T                   120 HYDRTRY      83 SASKGVL INERBED SNDGRVL   01766    1214      330        18        0.0
 023 17W4 36 16 02.0 RCA 7T                    92 HYDRTRY         SASKGVL INERBED SNDGRVL                                         0.0       0.0
 023 28W4 33 15 01.0 SMITH                     84 HYDRTRY       2 PASKAPO CRSGRND SNDSTON                                         0.0       0.0
 024 15W4 06 NE 01.0 PEAK                     220                                                                                 0.0       0.0
 024 15W4 06 15 01.0 RAUENHORP                 15     DUG       1                                                                 0.0       0.0
 024 15W4 07 15 01.0 PEAKE                     25     DUG            SAND             SAND                                      0.0       0.0
 024 15W4 17 00 91.0 PAETKAU                   94                                           00563    2944      265        96        1.0
 024 15W4 17 12 01.0 RUDEKOPP                  20     DUG       1    SAND             SAND                                      0.0       0.0
 024 15W4 18 03 01.0 LIEWEN                     9                    SAND             SAND                                      0.0       0.0
 024 15W4 18 16 01.0 NEWFIELD JOH              16     DUG            SAND             SAND                                      0.0       0.0
 024 15W4 19 01 01.0 NEWFIELD JAC               8     DUG            SAND             SAND                                      0.0       0.0
 024 15W4 27 SW 01.0 BECK                      55 HYDRTRY       4 SASKGVL INERBED SNDGRVL                                         0.0       0.0
 024 15W4 29 16 01.0 GILLESPIE                235 HYDRTRY       5                 SNDSTON                                         0.0       0.0
 024 15W4 30 06 01.0 DOUGLASS                  14     DUG       1    SAND             SAND                                      0.0       0.0
 024 16W4 24 00 91.0 GEELEMAN                 100                                           N2464     784      585        15                  0.0
 024 17W4 20 16 01.0 RCA 5                     60 HYDRTRY         SASKGVL INERBED SNDGRVL                                         0.0       0.0
 024 18W4 36 16 01.0 RCA 4                    210 HYDRTRY         SASKGVL INERBED SNDGRVL                                         0.0       0.0
 024 19W4 27 SE 91.0 HUSSAR                   110                                           N0664    1286      540                  2.0
 024 20W4 13 SE 91.0 EPP                      150                                           00564    1126       35        51                  0.0
 024 20W4 14 SE 01.0 AL WHEAT                 160 HYDRTRY             EDM             SNDSTON                                         0.0       0.0
 024 20W4 14 SE 02.0 MOULTEN                  140 HYDRTRY       9     EDM             SNDSTON                                         0.0       0.0
 024 20W4 14 00 01.0 SUNSHINE                 180 HYDRTRY                                                                         0.0       0.0
 024 20W4 14 00 02.0 GAUTHIER                 151   CABLE                                                                         0.0       0.0
 024 20W4 14 00 03.0 SUNSHINE                  90 HYDRTRY                                                                         0.0       0.0
 024 20W4 14 01 01.0 AL GAS TRUNK             120 HYDRTRY       6     EDM             SNDSTON                                         0.0       0.0
 024 21W4 10 SW 91.0 ANDERSON                                                               32161    1638      715         7        5.0
 024 21W4 11 13 01.0 CO OP                    119 HYDRTRY      12     EDM        HARD SNDSTON                                         0.0       0.0
 024 21W4 12 NW 91.0 ROGERS                                                                 21560    2466       70        21        3.0
 024 21W4 29 16 01.0 WATSON                    66 HYDRTRY      10     EDM             SNDSTON                                         0.0       0.0
 024 21W4 35 00 01.0 RASMUSSEN                150 HYDRTRY             EDM             SNDSTON                                         0.0       0.0
 024 21W4 35 00 02.0 RASMUSSEN                 60                     EDM             SNDSTON                                         0.0       0.0
 024 21W4 36 00 01.0 ALTA PACIFIC             130 HYDRTRY       6     EDM             SNDSTON                                         0.0       0.0
 024 22W4 03 NE 91.0 GREEN                     80                                           42764    2048      185        10        3.0
 024 22W4 12 NE 91.0 NERLAND                   90                                           12864    2594      170        15        0.0       0.0
 024 23W4 08 14 91.0 RAMSAY                   200                                           02463     828                183        0.0       2.0
 024 23W4 21 15 91.0 MORGAN                   300                                           11361     616       20         7        1.0       1.0
 024 23W4 31 01 91.0 DAMEN                     80                                           60363    1574       40         8                  1.0
 024 24W4 05 11 01.0 HARWOOD                   90  DRIVEN      50 PASKAPO                 SNDSTON                                         0.0       0.0
 024 24W4 07 12 91.0 SEITZ                    135                                           01362     704      165         3        0.0       0.0
 024 24W4 22 15 01.0 SIBLEY                   601               7 PASKAPO                 SNDSTON    0000
 024 24W4 29 04 91.0 HENDRICKS                 60                                           53163     872      525        37
 024 24W4 29 04 91.0 HENDRICKS                 80                                           62563     722      330        27
 024 24W4 29 04 91.0 HENDRICKS                 80                                           N0163     800      500        43
 024 25W4 06 00 91.0 BOWD                      55                                           81064     714      120        15
 024 25W4 08 16 01.0 SMOLANSKI                100  DRIVEN      20 PASKAPO                 SNDSTON                                         0.0       0.0
 024 25W4 10 14 01.0 TURKEYFARM                56  DRIVEN       5 PASKAPO                 SNDSTON                                         0.0       0.0
 024 25W4 11 15 01.0 FEEDMILL                 105  DRIVEN      15 PASKAPO         SOFT SNDSTON                                         0.0       0.0
 024 25W4 13 SE 01.0 ORNBURN                  281              12 PASKAPO         HARD SNDSTON                                         0.0       0.0
 024 25W4 14 05 01.0 STRATHMORE               440 HYDRTRY      37 PASKAPO                 SNDSTON                                         0.0       0.0
 024 25W4 24 15 91.0 LYONS W                  220                                           40262    1336       75       479        0.0       1.0
 024 25W4 24 15 92.0 LYONS E                  180                                           72064     786                 62                  2.0
 024 25W4 34 13 01.0 TAYLOR                   200 HYDRTRY       3 PASKAPO                 SNDSTON                                         0.0       0.0
 024 26W4 02 03 91.0 LAUSEN                                                                 50263    1114      410         5        0.0       0.0
 024 26W4 07 03 01.0 HECKLE                   145 HYDRTRY       2 PASKAPO                 SNDSTON                                         0.0       0.0
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Fig. 4. Computer output from the HYDRODAT system.

Information pertaining to approximately 50,000 wells can be permanently stored on one reel of magnetic tape. Should a tape be accidentally lost or destroyed, a duplicate can be made from the punch cards on file and, conversely, new cards can be generated from the tape.

Machine storage and retrieval is achieved using an IBM 7040/1401 computing system utilizing the COBOL-61 compiler language.

The conversion of basic well information into machine-processable form permits rapid access to and recovery of tremendous amounts of information in any desired sequence or form. The information shown in Figure 4 illustrates one of the many varied outputs from the HYDRODAT system. Computer time for this retrieval was twelve seconds.

The availability of a large body of facts consistently recorded will relieve the geologist and engineer of many routine and menial tasks. At present the manipulation of data occupies a great deal of time that should be devoted to the analysis of problems and to the means of their solution.

Master Files

The exchange of basic information among agencies involved in hydrologic studies may be accomplished by the adoption of standard coded master files by each participating agency. The master-file format recommended by the Canada Department of Energy, Mines and Resources is shown in Figure 5. The columns of the IBM punch card illustrated in the figure are subdivided into fields, each field being reserved for a specific class of information.

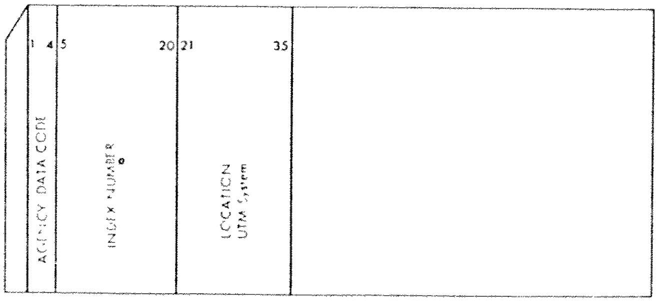

Fig. 5. Master file format recommended by the Canada Department of Energy, Mines and Resources.

The agency/data code is contained in the first field (columns 1-4). This field specifies the collecting agency and the type of data available. In the master file "AR" designates the Research Council of Alberta and the two numerical digits indicate the type of information available according to the following code:

10 – location, ownership, and well description data

20 – hydrogeologic data

30 – chemical quality-of-water data

40 – lithologic data

41 – additional lithologic data

The index number contained in the second field (columns 5-20) locates and identifies the observation for the collecting agency. This number gives the location in a form suitable for local use by the collecting agency but not necessarily adaptable to universal use.

The UTM location contained in the third field (columns 21-35), on the other hand, locates the observation according to a common national system of determining geographic location. A UTM location is required for every observation point.

The HYDRODAT system is compatible with this standard format. The first section of the well-schedule form (Figure 3a) contains the four-digit agency/data code, a 16-digit index number, and the UTM location in that order. As previously explained, the index number is based on the Dominion Lands System of Survey. Subsequent sections of the well-schedule form are prefixes with the appropriate agency/data code and with the index number.

Master files containing the first three fields of information are made available to participating agencies who may search them to determine what kind of information is available and where it is. Thus, a master-file code of AR30 would indicate that chemical quality-of-water data for a specific location is available at the Research Council of Alberta.

CONCLUSIONS

Use of the HYDRODAT system is expected to result in savings of manpower in that the actual time requirements for handling data will be reduced substantially. Various pieces of auxiliary equipment and additional computer programs will provide automatic preparation of data reports and will assist greatly in preparing the analytical evaluations necessary for interpretations of the ground-water resources of an area. More sophisticated results will be possible through the use of computer-oriented X-Y plotters.

The computer will not only furnish the geologist and engineer with rapid access to large volumes of data, but will also provide him with analytical methods which would otherwise be tedious, if not impossible, to apply by conventional methods.

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