

RESEARCH PROJECT TECHNICAL COMPLETION REPORT

CONTINUATION OF THE  
ARIZONA WATER INFORMATION SYSTEM (AWIS)

Office of Water Research and Technology  
Project A-031-ARIZ

Annual Allotment Agreement  
No. 14-31-0001-5003

FCST Research Category VII-C;  
OWRT Problem Area: 10

Principal Investigators

Kennith E. Foster  
Office of Arid Lands Studies  
University of Arizona

Kenneth J. DeCook  
Water Resources Research Center  
University of Arizona

Project Duration

June 1971 to June 1975

Funds provided by the United States Department  
of the Interior, Office of Water Research and Technology,  
as authorized under the Water Resources Research Act of 1964,  
supported much of the work described in this report.

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## INTRODUCTION

In 1971 the State of Arizona did not have an agency or system which was solely responsible for disseminating information relative to all aspects of Arizona water resources. Various users of Arizona water resources information had independent methods of obtaining information and seldom, if ever, did the information contain all that was available and appropriate. Often a considerable amount of non-relevant data was gathered to obtain even incomplete information. A system which would supply to a lawyer, researcher, or city planner, for example, all of the available pertinent information specific to his needs, would be of significant benefit. Such a system would save considerable time and money in terms of collecting, organizing, and analyzing existing data. Given assurance that all "available" information is available, water resources decisions may be based on more complete objective analyses. Further, researchers and students may be able to conduct some of their research on existing data, thus reducing a duplication of effort in terms of data collection.

### Objectives

Accordingly, upon initiation of Office of Water Research and Technology (OWRT) Project A-031-ARIZ, "Design and Pilot Study of an Arizona Water Information System (AWIS)," the following primary objectives were submitted to define project need: 1) the design of an information system which will permit users at any level (from individuals to federal agencies) to quickly and efficiently retrieve specific information relative to Arizona water resources; 2) ability of a user to request information via either data phone links, normal telephone, in person, or through

the mails--where output would be transmitted through data phone, mail, or courier; 3) a system simplicity--at least as far as the user is concerned. A secondary objective was cataloging all the various water information sources for Arizona water resources.

In accomplishing these objectives, all existing water resources information systems to the extent possible have been documented and studied, including the U. S. Department of Agriculture Current Research Information System (CRIS); the U. S. Department of the Interior (USDI) Office of Water Data Coordination (OWDC) and Storage and Retrieval System (STORETS); the USDI Office of Water Research and Technology (OWRT) Water Resources Scientific Information Center (WRSIC) RECON system; and all similar systems at the state and local level. Information in this context implies data (numerical and non-numerical) as well as formal and informal reports.

These systems and a brief documentation are outlined in Appendix C.

## PROJECT RESULTS

During FY 1972 the Arizona Water Information System (AWIS) contacted various agencies at federal, state and local levels to determine what contributions or needs in water resource data could be directed to a water information system. These contacts have resulted in close cooperation between the AWIS and numerous state agencies dealing with Arizona water resources. Work was initiated on a systems software package to store, update and retrieve water information and/or data.

A questionnaire was developed to solicit pertinent information from participants regarding their water resource activities. It soon became evident that many potential AWIS participants had efficient means of disseminating their

own water data; thus AWIS could function not as a data source, but rather as an information center to relay requests to an agency disseminating its own data.

Two computerized files were established during the pilot year. One is a file containing water resource activities in Arizona beginning in 1961. This information can be accessed by keywords or the agency name performing the activity. The other is a water quality data file prepared in cooperation with the State Health Department. These data can be accessed by type of data (water quality, aquifer parameters, etc.), location or specific item values.

In 1973 AWIS expanded with the acquisition of additional water resource projects information supplied through questionnaire response from local, state and federal agency programs (Appendix A). To date almost 1,000 projects have been identified and placed on magnetic tape for subsequent computer retrieval and AWIS is now being updated through a three-state program involving Arizona, California and Nevada. Information can be accessed by a number of parameters including keywords, agency doing the work, province, county, river basin, or township, range and section. For example, if one would like to know what sewage effluent research is ongoing in Pima County the file can be queried and if the combination of geographic locator (Pima County) and the keyword (sewage effluent) exists that project will be retrieved and printed.

Water information dissemination was not limited to the computer aspects of AWIS. In November 1972, a cassette tape series was initiated entitled "Current Trends in Arizona Water Resource Development." Each tape is a 20-25 minute narrative presentation aimed at non-technical groups to help them keep abreast of developments in their area of interest.

The two cassette tapes were well received. Contributions to the cassette tape series have not been limited to water center personnel. Manuscript preparation

has been provided from several other institutional departments and agencies in Arizona. This approach offers a unique opportunity to disseminate information from a broad professional base working in Arizona water resource fields.

A questionnaire was developed to evaluate the utility of the cassette program. Over 50 agencies or groups indicated willingness to subscribe tapes offered on a monthly subscription basis.

In June 1973 the Water Resources Research Center, in cooperation with the Office of Arid Lands Studies, planned a one-day, western-state conference on water information dissemination. The conference was held in Phoenix on June 8, and dealt with water resources information dissemination activities of the several states. How the OWRT Program can better respond to State needs (Arizona as an example), and needs and opportunities for coordinated regional or interstate action were topics of discussion.

About the same time, OALS and WRRC laid groundwork for a newsletter jointly published with the Arizona Water Commission, the state water planning agency. Beginning in FY 74 the bi-monthly publication of a statewide newsletter, "Arizona Water Resources News Bulletin," kept readers informed of water research publications, upcoming events and water resource developments within the state. Six editions were prepared during the fiscal year. The periodic "Arizona Water Resources Project Information Bulletin" was initiated to disseminate information relating to individual project findings. To date the following bulletins have been prepared:

1. A Methodology for Planning Land Use and Engineering Alternatives for Floodplain Management
2. Technical, Economic and Legal Aspects Involved in the Exchange of Sewage Effluent for Irrigation Water for Municipal Use: Case Study--City of Tucson

3. Geophysical Aspects of Groundwater Exploration in the Alluvial Basins of Southern Arizona
4. Selected Abstracts from Arizona Section, American Water Resources Association and the Hydrology Section, Arizona Academy of Sciences Annual Meeting in Flagstaff, April 19-20, 1974
5. Selected Abstracts from Arizona Section, American Water Resources Association and the Hydrology Section, Arizona Academy of Sciences Annual Meeting in Flagstaff, April 19-20, 1974
6. WAMIS--A Bibliographic Information System for Water Yield Improvement
7. Development of Forest Management Guidelines for Increasing Snowpack Water Yields in Arizona
8. Coolidge Regional Park Project
9. Selected Abstracts from Arizona Section, American Water Resources Association and the Hydrology Section, Arizona Academy of Sciences Annual Meeting in Tempe, April 11-12, 1975
10. Selected Abstracts from Arizona Section, American Water Resources Association and the Hydrology Section, Arizona Academy of Sciences Annual Meeting in Tempe, April 11-12, 1975
11. Completion of Phase I--Arizona State Water Plan
12. Orbital and High Altitude Imagery as a Management Tool for Land Use and Flood Hazard Studies
13. Phase II--Arizona State Water Plan
14. Implementing the National Environmental Policy Act: An Overview

Midway in FY 74 the University of Arizona acquired a DEC-10 computer system capable of interactive hydrologic data processing. The utility of access to hydrologic data by a remote terminal is now demonstrated. The Arizona Water Commission (AWC) contributed funds to AWIS to develop hydrologic data

storage and retrieval capability on the DEC-10 for access in Phoenix. This pilot study phase of AWIS, "Implementation of AWIS Remote Terminal Accessible Hydrologic Data Sets on DEC-10 Computer," is designed to answer routine Arizona water resources questions easily, economically and on short notice. The expansion of AWIS capability for remote hydrologic data access will facilitate AWC efforts to evaluate the efficiency of a water information system for state government. Partial state support of AWIS is an indication of the success and need for such a system in Arizona.

During FY 75 an evaluation and extension of AWIS was accomplished to increase remote access of AWC-supplied hydrologic data with the University of Arizona DEC-10 computer system. Evaluation of public acceptance of current information dissemination techniques, such as the Water Resources News Bulletin and Project Bulletin series, was conducted. The results are shown in Appendix B. A user's guide was developed for state institutions and planning agencies interested in remotely accessing water data on-line (Appendix D).

The questionnaire shown in Appendix B indicated a positive response to continue the News Bulletin in essentially the same format as had been previously established. Of interest is the high percentage of readers requesting articles relevant to Arizona, governmental agency action and upcoming events.

The OALS, the WRRC and the AWC are continuing development of a generalized data storage and retrieval system with the DEC-10 system at the University of Arizona for systematic recording of groundwater quality and quantity information within Arizona. Currently two data files are in AWIS whereby water-related information can be extracted locally by quarter-township or regionally by drainage basin. This information was supplied by AWC, which is not collecting primary water data, but is using water data from other sources

to prepare reports and maps describing Arizona groundwater as well as providing some supplemental information whenever possible. The following kinds of groundwater information are examined comprehensively statewide in general detail, but not intensively:

- a. quality
- b. water level
- c. storage amount
- d. pumpage
- e. potential well production

Information stored in AWIS has been taken from two maps developed by AWC:

"Potential well production, water surface elevation, and direction of groundwater flow in Arizona"

"Quality of groundwater, changes in water levels, amounts of groundwater in storage, and groundwater pumpage in Arizona."

The type of information stored on the DEC-10 for each file is shown in Tables 1 and 2. It is anticipated that the utility of remotely accessing these data by the AWC and state planning agencies will be evaluated with funds provided by the State of Arizona.

The on-line access to hydrologic data supplied by AWC is but one phase of AWIS developed during the FY 75. AWIS has become an integral part of the overall WRRC program to disseminate scientific Arizona water resources information.

Table 1. AWC Groundwater Information by Quarter Township

AWIS - DEC-10 Data Bank  
 Arizona Water Commission  
 Township File-TWN

Item Description	*Item Number*	Information
Computer Code Number	*1*	
Township	*2*	
Range	*3*	
Quarter Township	*4*	
Section	*5*	
Quarter Section	*6*	
Basin	*7*	
County	*8*	
Potential Well Production (gpm)	*9*	
Surface Water Elevation (ft. above sea level)	*10*	
Depth to Water in Feet Below Land Surface (contour)	*11*	
Depth to Water in Feet Below Land Surface (point)	*12*	
Dry Well at Indicated Depth	*13*	
Water Level Change	*14*	
Period of Change	*15*	
Dissolved Solids (mg/l)	*16*	
Specific Conductance (micromhos @ 25 <sup>o</sup> C)	*17*	

Table 2. AWC Groundwater Information by Basin

AWIS - DEC-10 Data Bank  
 Arizona Water Commission  
 Basin File-BAS

Item Description	*Item Number*	Information
Computer Code Number	*1*	
Basin	*2*	
Groundwater in Storage to 1200 Feet Below Surface (ac. ft. X1000)	*3*	
Groundwater Pumped Since Basin Development (ac. ft. X1000)	*4*	
Amount Pumped in 1971 (ac. ft. X1000)	*5*	
Worth of Data	*6*	
Bibliographic References	*7*	

## PUBLICATIONS

- Cluff, C. B., 1972, "Water Conservation," Current Trends in Arizona Water Resource Development, Cassette Tape No. 1.
- Foster, K. E., 1973, "A Computerized Information System Relative to Arizona's Water Resources," 1973 Proceedings Institute of Environmental Sciences, pp. 341-344.
- Foster, K. E., 1974, "Data Storage and Handling Systems," Proceedings of the 1974 annual meeting of the Arizona Water Resources Association and the Hydrology Section, Arizona Academy of Sciences, pp. 217-230.
- Foster, K. E., and J. D. Johnson, 1972, "Design and Pilot Study of an Arizona Water Information System," Proceedings of the 1972 annual meeting of the Arizona Water Resources Association and the Hydrology Section, Arizona Academy of Sciences, pp. 43-52.
- Matlock, W. G., Dutt, G., and Frost, K., 1973, "Farming the Desert" Current Trends in Arizona Water Resource Development, Cassette Tape No. 2.
- University of Arizona, 1973, "Western State Conference on Water Information Dissemination," Water Resources Research Center, Tucson, 98p. (Conference held in Phoenix, Arizona, June 8, 1973).

## APPENDIX A

### Name-Address of Institutions Where Water-Related Research is Conducted

- 1) University of Arizona, Tucson, AZ 85721
- 2) Rocky Mountain Forest and Range Experiment Station, Arizona State University, Tempe, AZ
- 3) Department of Economic Planning and Development, Phoenix, AZ 85012
- 4) Forest Supervisor, Tonto National Forest, 230 N. 1st Ave., Phoenix, AZ 85025
- 5) U.S. Geological Survey, Tucson, AZ
- 6) Tucson Water Department, Tucson, AZ
- 7) Agricultural Experiment Station, University of Arizona, Tucson, AZ
- 8) Engineering Experiment Station, University of Arizona, Tucson, AZ
- 9) Arizona Municipal Water Users Association, Phoenix, AZ
- 10) U.S. Department of Agriculture, Tucson, AZ
- 11) S.W.C. Research Division, U.S.D.A., Phoenix, AZ, U.S. Water Conservation Laboratory
- 12) U.S. Geological Survey, Phoenix, AZ
- 13) Beltsville, Maryland Plant Industry Station
- 14) Arizona Game and Fish Department, 2222 W. Greenway Rd., Phoenix, AZ 85023
- 15) Arizona State University, Tempe, AZ
- 16) Infilco, Inc., Tucson, AZ
- 17) U.S. Department of Agriculture, Phoenix, AZ
- 18) Soil Conservation Service, 230 N. 1st Ave., Phoenix, AZ 85025
- 19) Area Director, Bureau of Indian Affairs, 124 W. Thomas Rd., Phoenix, AZ 85003
- 20) Colorado State University
- 21) State Director, Bureau of Land Management, 230 N. 1st Ave., Phoenix, AZ 85025
- 22) Field Supervisor, Division of River Basin Studies, 522 N. Central Ave., Phoenix, AZ 85025
- 23) Atomic Energy Commission
- 24) Salt River Project, Phoenix, AZ
- 25) S.W.C. Research Division, U.S.D.A., Tucson, AZ, Southwest Watershed Research Center
- 26) Rockefeller Foundation
- 27) U.S. Geological Survey, Denver, Colorado
- 28) Smithsonian Institute
- 29) Phoenix Municipal Government, Phoenix, AZ
- 30) Northern Arizona University, Flagstaff, AZ
- 31) State Supervisor, Division of Wildlife Service, 2721 N. Central Ave., Phoenix, AZ
- 32) Regional Director, Bureau of Reclamation Region 111, Boulder City, Nevada 89005
- 33) Arizona State Health Department, Water Supply Division, Phoenix, AZ
- 34) Arizona Water Commission, Phoenix, AZ
- 35) Arizona State Land Department, Phoenix, AZ
- 36) Arizona Highway Department, Phoenix, AZ
- 37) Aerojet General Corporation, 9200 E. Flair Dr., El Monte, CA
- 38) Westinghouse Electric Corp., Tucson, AZ
- 39) Fuhrman Barton Associates, Provo, Utah
- 40) Garrett Corporation, 402 S. 36th St., Phoenix, AZ
- 41) U.S. Veterans Administration Hospital, 3661 6th St., Tucson, AZ

- 42) U.S. Geological Survey, Yuma, AZ
- 43) U.S. Geological Survey, Flagstaff, AZ
- 44) Bureau of Sport Fisheries and Wildlife, P. O. Box 1306, Albuquerque, NM 87103
- 45) Water Development Corp., Tucson, AZ
- 46) Flagstaff City Engineer, 14 W. Aspen Ave., Flagstaff, AZ
- 47) Soil Conservation Service, Flagstaff, AZ
- 48) Little Colorado River Plateau RC & D, Box 36, Woodruff, AZ
- 49) Harza Engineering Co., 420 W. Madison St., Chicago, Illinois
- 50) Engineering Science, Inc., Arcadia, CA
- 51) Hurricane Valley N.R.C.D., Box 104, Littlefield, AZ
- 52) Dos Cabezas Flood Control District, 1007 Granada South, Willcox, AZ 85643
- 53) Magma Flood Control District, Rt. 1, Box 38A, Florence, AZ 85232
- 54) Vanar Wash Flood Control District, San Simon, AZ
- 55) Maricopa Co. Flood Control District, 3325 W. Durango, Phoenix, AZ
- 56) Graham Co. Board of Supervisors, Graham Co. Court House, Safford, AZ 85546
- 57) Silver Cr. Flood Control District, 214 W. Hunt Ave., Snowflake, AZ 85937
- 58) Florence Area Flood Control District, Rt. 1, Box 8, Florence, AZ 85232
- 59) Fredonia Flood Control District, Fredonia, AZ
- 60) Agua Fria -S- New River N.R.C.D., P. O. Box 327, Cashion, AZ
- 61) U.S. Army Corp of Engineers, Federal Bldg., 300 N. Los Angeles St., Los Angeles, CA 90012
- 62) Rocky Mountain Forest and Range Experimental Station, Northern Arizona University, Flagstaff, AZ

APPENDIX B  
EVALUATION ARIZONA WATER RESOURCES NEWS BULLETIN  
June 1975

The purpose of this evaluation is to obtain readership reaction to the News Bulletin. One hundred thirteen readers responded to the questionnaire, and the percentage given at right represent reader response to the question.

	<u>% of 113 responses</u>
A. Would you like to continue receiving this News Bulletin?	
1. Yes -----	<u>99</u>
2. No -----	<u>1</u>
B. Do you prefer the current bimonthly schedule?	
1. Yes -----	<u>77</u>
2. No -----	<u>18</u>
3. No preference -----	<u>5</u>
C. If not, would you prefer publication?	
1. Monthly -----	<u>14</u>
2. Quarterly -----	<u>4</u>
D. What type of information related to water would you like to see in <u>each</u> issue? (Check all appropriate categories.)	
1. Specific governmental agency action relevant to water -----	<u>78</u>
2. Description of existing or pending legislation -----	<u>66</u>
3. Brief comments on stories or article summaries relevant to Arizona -----	<u>81</u>
4. Editorials (guest or regular) -----	<u>38</u>
5. Upcoming events (conferences and symposia) -----	<u>70</u>
6. Other (explain under G) -----	<u>11</u>
E. What type of information related to water would you like to see in the News Bulletin, but <u>not necessarily</u> in <u>each</u> issue? (Check all appropriate categories.)	
1. Specific governmental agency action relevant to water -----	<u>50</u>
2. Description of existing or pending legislation -----	<u>50</u>
3. Brief comments on stories or article summaries relevant to Arizona -----	<u>45</u>
4. Editorials (guest or regular) -----	<u>41</u>
5. Upcoming events (conferences and symposia) -----	<u>40</u>
6. Other (explain under G) -----	<u>6</u>
F. Please check the <u>one</u> category that best describes your interest*	
1. University or college faculty, staff, or student -----	<u>28</u>
2. Secondary education -----	<u>0</u>
3. Farm or ranch -----	<u>4</u>
4. Industry -----	<u>11</u>
5. Federal government -----	<u>24</u>
6. State or local government -----	<u>25</u>
7. Environmentalist-conservationist -----	<u>8</u>
8. Consultant or other private firm -----	<u>8</u>
9. Other (specify under G) -----	<u>4</u>

\*The sum of the nine categories is greater than 100% thus indicating some readers checked more than one category.

## APPENDIX C

### AN OVERVIEW OF STORAGE AND RETRIEVAL SYSTEMS\*

#### INTRODUCTION

There is no universally accepted definition for the term data. At times the term refers only to recorded observations of natural phenomena; at other times it refers more broadly to results of calculations and human judgements.

Also, distinctions must be made between "raw" and "processed" data. Raw data are the actual observations made in the field, while processed data are raw data which have been put into a form that will facilitate use and understanding. For example, current meter readings or water quality samples are raw data while tabulations of daily stream discharge are processed data. In this report the term data will refer to processed data.

From a data bank viewpoint, data can exist in two forms: "hard" and "soft." Herein, hard data is the term applied to numerical and narrative data that can be processed by a computer. These are data that are actually filed on magnetic tape, disk, card, drum, or other processing media. Soft data is the term applied to data and information that cannot be processed by electronic data processing equipment.

#### DEFINITIONS COMMONLY ASSOCIATED WITH STORAGE AND RETRIEVAL SYSTEMS

Information. Information is defined as those data items which have been modified by numerical calculations or human judgement for use in planning, justification, construction, operation, and management of water resource systems. Examples

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\*Reprinted from "Hydrology and Water Resources in Arizona and the Southwest," Volume 4, pp. 217-230 (1974).

of information are projected streamflow and water uses. Here again, the information can exist in either a hard or soft form.

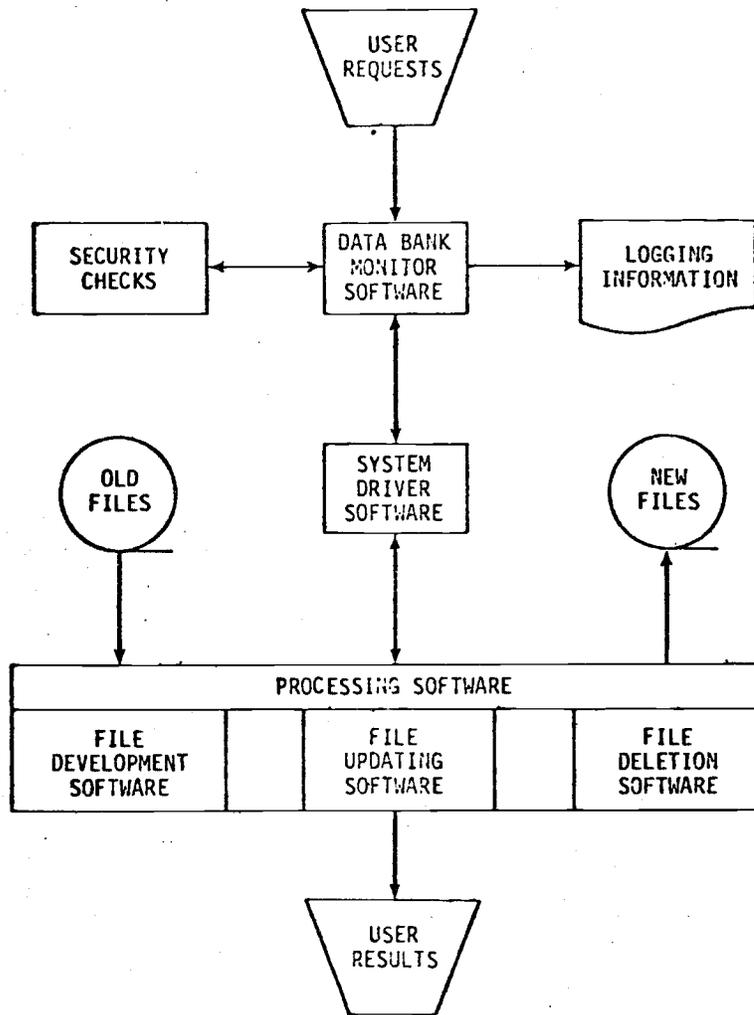
Basic Data Management. Basic data management refers to the total program for observing, collecting, recording, storing, retrieving, presenting, preparing for use, and publishing basic data to meet, as well as possible, all of the needs of the donor agencies and other participating entities.

Data Bank. Data bank is defined as a collection of data and information stored in specific files that are either numeric or narrative in nature; that may be stored in a centralized location; that are fully described for user access by catalogs and/or narrative index material; that can be retrieved, irrespective of storage form or location by a set of standardized retrieval codes and/or formats; and that have specific security protection features which are responsive to user needs yet protect the supplying entities.

The term data bank implies the need for computer hardware and software required not only to store and retrieve hard data and information but also to provide sufficient supporting computational services to retrieve material in a form most useful to the user entity and within a time period responsive to his needs.

Figures 1 and 2 show the basic structure of the storage and retrieval portion of the data management system. The data bank monitor receives all input requests, determines which processing software will be used; logs in each inquiry into the system; and establishes multiple programming input cues based upon file availability, core requirements, and device requirements.

Next, the system driver program determines which functions are to be performed by the processing software, loads the necessary software into the computer (passing



**Figure 1.** General Design Features of the Hard File Development and Update Sub-System.

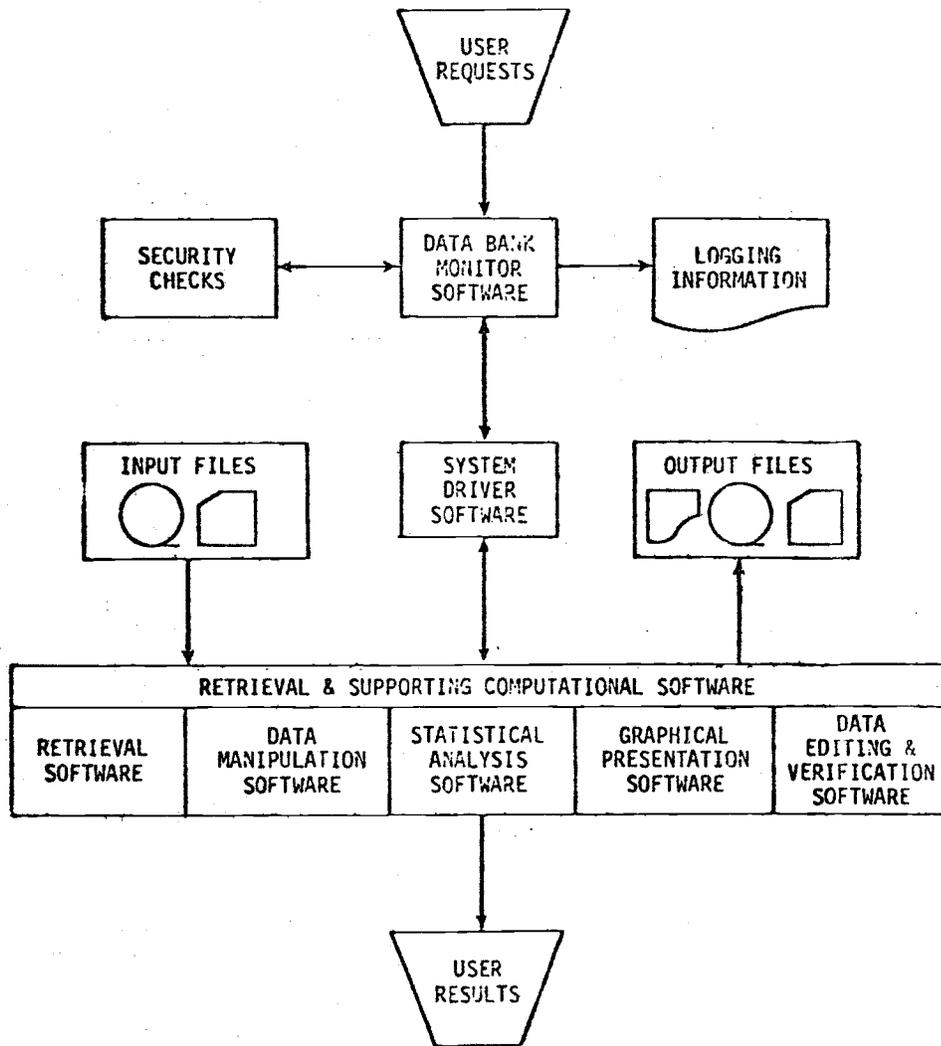


Figure 2. General Design Features of the Hard File Retrieval Sub-System.

any necessary parameters and receiving control back from the sub-programs), and transfers control to the processing software to perform the required data manipulations — 1) updating a file, 2) extracting selective information, 3) plotting information, and 4) performing statistical analysis on extracted data.

Upon completion of the data manipulations requested, the processing software returns control back to the system driver. The system driver then interrogates the user's request to determine if all activities were performed and appropriately terminates the processing of the user's request.

Because a distinct difference does exist between data handling and information handling systems, a review of the two systems now in operation and user access to these systems is in order.

#### REVIEW OF INFORMATION SYSTEMS

Smithsonian Science Information Exchange (SSIE). The SSIE annually collects 85,000 to 100,000 single page records of research projects currently in progress. The projects are funded by both public and private sources of support. Each record describes who supports the project, who does it, where and when the research is performed, and includes a technical summary of the project. To obtain more information pertaining to the SSIE, inquiries should be addressed 1730 M Street, N.W. Washington, D.C. or call 202-381-5511.

#### Current Research Information System (CRIS), U. S. Department of Agriculture.

The CRIS annually collects records of new and continuing research for seven organizations within the USDA. Each record describes who supports the project, who does it, where and when the research is performed, technical summary, and any publications produced during the yearly reporting period. To date about

24,000 project descriptions are on file from the Agricultural Research Service, Forest Service, Economic Research Service, Cooperative State Research Service, Farmer Cooperative Service, the Statistical Reporting Service, and 53 State Agricultural Experiment Stations.

CRIS searches are provided to all agencies of USDA, to State Agricultural Experiment Stations, State Extension Services, and universities.

Generalized Information Processing System (GIPSY). GIPSY is a computerized storage and retrieval system for water resources information, developed by the Water Resources Scientific Information Center, Office of Water Resources Research. Water resource abstracts of current and earlier pertinent monographs, journal articles, reports and other publication formats are on file. The contents of these documents cover the water-related aspects of the life, physical and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water.

The citations have been housed on computer file at the University of Oklahoma with connecting terminals located at those state water resources research institutes located at the University of Wisconsin, Cornell University, and North Carolina State University.

Interested users in Arizona should contact the Water Resources Information Program, University of Wisconsin, 1324 West Dayton Street, Madison, Wisconsin for retrievals. To date over 60,000 citations are on file.

Oak Ridge National Laboratory. This agency publishes Abstracts of the IBP's Ecosystem Analysis Studies (current issue is V. 3, No. 4, Dec. 1973), which serves as a communication link between the Biome Programs that constitute part of the Environmental Component of the U. S. International Biological Program,

and between the various Biomes and the Scientific community. Groups currently participating in this effort include the Coniferous Forest, Desert, Eastern Deciduous Forest, and Grasslands Biomes, and the Island Ecosystems and Upwelling Programs.

It includes abstracts of reports or data sets for each of these biomes, including work in progress as well as publications. It is submitted in machine readable form under a program that forms part of the Oak Ridge Computerized Hierarchical Information System (ORCHIS) operated by the Laboratory Mathematics Department. From these computer files, material for publication in the Abstracts is selected and manipulated by computer programs to produce the body and indexes in each issue. All material submitted by the various biomes and Programs is stored on data cells to be accessed by a conversational retrieval program.

Not all issues carry abstracts from all biomes. Each issue has indexes for investigator, keyword, taxonomic name, and subject category for each abstract appearing in that number. Some of the subject categories carried in the December 1973 issue were: aquatic, decomposition, hydrology, invertebrates, modeling, nutrient cycling, productivity, and terrestrial.

It too, like the OALS, has its own Environmental Terminology Index, developed with NSF funding, a much broader tool than the Arid Lands Thesaurus because it covers all environments encompassed by the entire IBP program.

Arid Lands Information System (ALIS). After a development period of NSF funding, the Arid Lands Information System (ALIS) within the OALS is now fully operational, with a modest bank covering worldwide arid lands scientific information relating to the physical and biological aspects of world deserts. One subsystem, relating to specialized information on watershed management, is functioning within the larger framework and will be discussed in the next presentation.

Publications generated by the stored information include Arid Lands Abstracts featuring not only current publications arranged by subject categories such as Environmental Engineering, Geography and Geomorphology, Land Use, Weather and Climate, and Bibliographies, but also carrying in each issue a special retrospective bibliography on a particular arid land topic. Specials appearing to date include those on Burning as a Tool for Arid Range Management, Creosote bush, and Physiological Response to Heat Stress. In addition to this irregularly issued serial is another entitled Arid Lands Information Papers which are specialized bibliographies accompanied by substantive textual interpretation. To date papers have been prepared for Salinity Problems in Arid Lands Irrigation, Geothermal Exploration, Desertification, and Southwestern Groundwater Law. One on Jojoba is in preparation.

In addition to such publications, the ALIS system can retrieve from the machine readable data base by any mix or match of indexing terminology for customized searches. This operation combines all aspects of a complete index-abstract-information service, from research and selection, to production and promotion of the end product.

The computerized storage-and retrieval system includes verified standard bibliographical information such as author, date, title, and source, plus abstracts, plus keyword indexing from the Thesaurus of Arid Lands Terminology, developed to OALS under NSF funding. This thesaurus consists of over 3,000 terms, with hierarchical arrangement and scope notes.

The ALIS system is now formalizing alliances with such arid foreign countries as Israel and Australia, to create an international arid lands information network. The Israeli partnership has just been funded by the U. S. - Israel Binational Science Foundation.

## DATA STORAGE AND RETRIEVAL SYSTEMS

U. S. Geological Survey Data-Processing System. The U. S. Geological Survey data-processing system was developed between 1963 and 1965 to handle a rapidly increasing volume of hydrologic data more efficiently. This computer-oriented system (Johnson, 1965) uses punch cards for recording data from laboratory tests of geological materials, the quality of ground water, the physical and chemical quality of surface water, spring inventory data, water use, and water level data.

Current access to the system can be made through the USGS, Water Resources Division in Tucson which now has access capability to the data through a medium-speed printing device.

In this system, the forms, punch cards, and procedures for working with well and spring inventories, ground-water quality, water levels and water-use data are of particular interest. The basic elements of the USGS ground-water storage and retrieval system are:

"1) A well schedule and other forms designed to record data in the same order and manner that they will appear on the punch cards, 2) a series of cards for storing the data. Some data have been coded for conciseness and to present the data in a more useful form. Use of the codes will allow direct printouts of certain data from the cards in tabular form suitable for the use in various types of ground-water reports."

The USGS system for recoding well-inventory data consists of three cards - designated A, B, and C cards. The A card is a master card describing location, ownership, and data available. Card B is a well-description card, which includes information such as the physical characteristics of the well, water levels, yield, and select quality of water data. The information on Card C describes the physiographic and topographic setting, the geology, and the aquifer characteristics.

Water-quality data are punched onto three cards - the Q, R, and S cards. These cards contain the sample location, depth, results of the analysis for most dissolved chemical constituents, and physical properties. Spectrographic analysis of constituents in water is punched on cards T, U, and V. Card Y of the USGS system is for recording ground-water use in an area. Card Z is an aperture card for storing diagrammatic, graphic, and tabulated material; microfilm can be inserted in the aperture, which is a small cutout square.

Water-level data are recorded on cards designated 1, 2, 3-20, 101-999. The 1 card contains data on location, owner, use of well and water, and geologic units. The information on card 2 includes depth, description of measuring point, and records available. Cards 3-20 and cards 101-999 contain a narrative description of the well location, and the latitude-longitude of the well, and the water-level data.

All USGS records are referenced to latitude-longitude, which if properly used will result in a unique number for each location. All records having the same latitude-longitude should be from the same inventory site.

Canadian HYDRODAT System. Recognizing the significance of electronic data processing, the Canadian National Advisory Committee in 1964 requested that the Geological Survey of Canada investigate the feasibility of establishing a geological storage and retrieval system. The objectives of this study were as follows:

- 1) To study the current and potential uses, requirements, and problems in the recording, storage, and retrieval of geological data using electronic data-processing methods.
- 2) To recommend the principles to be followed in developing a National system for the recording, storage and retrieval of geologic data.

- 3) To develop a method of indexing which will serve as a key to the existence and location of geological data and thereby be fundamental to the retrieval, exchange and utilization data.
- 4) To undertake pilot studies that test the principles on which the National system is based, and that also develop standards for recording data in specific fields.
- 5) To propose an organization to continue the development of a National system.

Mineral-deposits data, fossil-fuel data, and geophysical and geochemical data were the specific areas of geological field data that were designated for the initial development of computer-processable files.

As a result of the Canadian studies, a computer-oriented system for the storage and retrieval of ground-water data was developed. The Canadian system, termed the HYDRODAT system is similar in format to the USGS system and incorporates many of the same codes and coding techniques.

The basic element of the HYDRODAT system is a well-schedule form for recording and coding data. The well-schedule form is divided into four major sections:

- 1) Location, ownership, and well-description data
- 2) Hydrogeologic data
- 3) Chemical quality-of-water data
- 4) Lithologic data

Data from the forms are punched onto standard computer cards for processing.

With the exception of lithologic data, the HYDRODAT system is a much shortened version of the USGS system. For example, in the HYDRODAT system, one punch card is used for chemical quality, whereas in the USGS system, three

cards are used for water quality and three more cards for spectrographic analysis of trace constituents.

Oil Industry Systems. The oil industry has expended considerable funds and effort in the development of computer oriented systems for storage, retrieval and manipulation of well data. Data from oil and gas wells, of course, differ from water-well data, but there are probably more similarities than differences between the two types of wells. The large investment and the extensive experience of the oil industry with well data cannot be ignored in developing a natural resource information system. Of the data-processing systems developed by oil companies, the Permian Basin Well Data System (PBWDS) is probably the best known because of its scope and wide use. This system represents the efforts of several oil companies to put geological and drilling data from wells in the Permian Basin of Texas and New Mexico onto magnetic tapes. After selection of data formats and development of a manual of instructions in 1963, the job of storing data was begun. To date over from 124, 792 historical wells and 10, 858 current wells were put on magnetic tapes.

Alpha and numeric codes were developed for such things as operators, formations, well classifications, producing fields and reservoirs, lithologies, porosity, oil or gas shows, and regulatory bodies. Well data are recorded on coding sheets according to these codes and then punched onto standard 80-space computer cards. About 180 items can be coded for a well by use of 21 different types of cards. The coded data include such information as the unique well number, formation tops, drill-stem tests, location, logs available, drilling problems, type of well and well owner. Once on cards, the data are stored on magnetic tapes. Retrieval of the coded data is facilitated by use of subprograms, which can exclude redundant data, test the records to see whether they contain useful data, and translate the coded

data into easy-to-read output complete with headings. Other programs are used to change, add to, or delete from the stored data, to transmit data to x-y plotters according to the latitude-longitude coordinates of the wells, to draw cross sections and contour maps, and for many other user-oriented applications.

STORET System. The Water Quality Data Storage and Retrieval System (STORET) was developed by the U. S. Public Health Service in 1961 and is now being widely used by the EPA. The STORET system enables storage and retrieval of water-quality data in a variety of forms, and for any statistical load and correlation computations that may be desired for data analysis and interpretation.

The basic elements of the STORET system are:

STORET Subsystem II consists of 1) a series of related computer programs designed for the efficient storage and retrieval of data collected in connection with water quality management programs. The system utilizes latitude and longitude to identify the location of data collection points and is intended for use in handling data collected from large open bodies of water and from points on land areas which cannot be associated readily with points on a stream, 2) a stream mileage and indexing method of locating data collection points for storing and retrieving water quality. STORET Subsystem II then, should be considered as a complementary system designed to serve in areas where STORET Subsystems I will not function effectively. Plans are under way to provide a link between the two subsystems so that, as a secondary measure, it will be possible to retrieve data stored in STORET I by using the techniques of STORET II.

The STORET Subsystem I used five cards for the location and description of the sample site. Parameter cards are used to store the water-quality data. On the card, five columns are used for the particular parameter, four columns for

the significant figures of the parameter, two columns for the exponent, and one column for remarks. Five parameters can be stored on each card, and any number of cards can be used. Parameter abbreviation cards are used to store the column headings for the data printouts. The parameter control card is used to retrieve particular parameters, and five station control cards are used to retrieve data from individual stations.

The STORET Subsystem II uses four cards for the location and description of sample sites. Parameter cards are again used to store water-quality data. A parameter control card and two other control cards are used to retrieve the data.

The STORET System is designed primarily to process data from surface-water supplies. The system is flexible, however, can be used for a wide variety of water-quality problems. Data from diverse sources can be stored and several programs have been written to perform analyses of these data.

Montana System. In Montana, with the support from the Montana Water Resources Research Council and the Montana Bureau of Mines and Geology, an investigation of the use of a computer-oriented system for processing ground-water data was begun in 1967. At present, the Montana Bureau of Mines and Geology in cooperation with the U. S. Geological Survey engaged in a program of evaluating the ground-water resources of the state in this ongoing system.

North Carolina System. A computerized system for storage, retrieval and routine processing of hydrologic data has been developed at North Carolina State University. Data on streamflow, rainfall, temperature, snowfall, evaporation and peak flow are stored. System capability permits listing of data and various statistical operations.

Nevada System. A storage and retrieval station was developed by the Center for Water Resources Research in order to centralize data used in research. Data currently being collected are water analyses, well logs, and surface-water discharge.

Texas System. The Texas Water Development Board has been designated by the State legislature to be the centralized agency for collection and dissemination of water data in Texas. The Board is currently in the process of developing means to store and retrieve U. S. Geological Survey stream flow data and NOAA weather data for 52 recording stations in Texas. Their current needs call for retrieving data by date or station number.

APPENDIX D

INTRODUCTORY USERS MANUAL  
TO THE ARIZONA WATER INFORMATION SYSTEM (AWIS)

Developed by  
the  
Office of Arid Lands Studies  
and the  
Water Resources Research Center  
The University of Arizona  
Tucson, Arizona

In cooperation with  
the  
Arizona Water Commission  
Phoenix, Arizona

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INTRODUCTORY USERS MANUAL TO  
THE ARIZONA WATER INFORMATION SYSTEM (AWIS)

INTRODUCTION

The Office of Arid Lands Studies (OALS) and the Water Resources Research Center (WRRRC), of the University of Arizona, and the Arizona Water Commission (AWC) have developed a generalized data storage and retrieval system on the DEC-10 computer system at the University of Arizona for systematic reporting of water information (quality and quantity) within the state of Arizona. The objective of the on-line system is to expand the AWC's efficiency in answering routine questions regarding Arizona's water resources easily and on short notice through remote terminal access to hydrologic information.

Currently, two files reside on AWIS whereby water-related information can be extracted for the entire State on either quarter-township basis or regionally by drainage basin. AWC is given authority to "collect and investigate information upon and prepare and devise means and plans for the development, conservation, and utilization of all waterways, watersheds, subterranean waters, groundwater basins and water resources in the State...". To this end, AWC is developing a State Water Plan, and the data residing on the two files in AWIS are part

of the Plan's first phase--an inventory of the resource, current uses and associated problems as presented in Arizona Water Commission Report "Arizona State Water Plan, Inventory of Resources and Uses, Phase 1, July, 1975."

## SYSTEM DESIGN

### Step 1: Getting on the System

To gain access to AWIS, one must "log in". When the terminal is turned ON, type a <sup>^</sup>C (depress the CTRL key and C key simultaneously). This action establishes communication with the monitor. The monitor signified its readiness to accept commands by typing "University of Arizona", the current time, and "please LOGIN or ATTACH", then responding with a period(.). All the commands discussed in this manual can only be typed to the monitor. They are operative when the monitor has typed a period (.), signifying that it is waiting for a command.

The first program the monitor calls is the LOGIN program. That is accomplished by typing LOGIN followed by a carriage-return (depress the RETURN key). All commands to the monitor should be terminated with a carriage-return. When the monitor "sees" a carriage-return, it knows that a command has been typed and it begins to execute the command.

(In the text of the manual, underscoring is used to designate terminal output. A carriage-return is designated by a . . .)

By typing LOGIN, the monitor reads the LOGIN program from the disk into core memory, and it is this program that is now in control of the terminal. The system responds with the following: #. The number sign (#), which is typed out by the LOGIN program, signifies that it wants your identification.

The standard identification code is in the form of project numbers (6100) and programmer numbers (2500). The LOGIN program waits for you to type in your project number and your programmer number, separated by a comma and terminated with a carriage-return, following the number sign.

# 6100, 2500

PASSWORD:

An alternate method of typing in your project number and programmer number is to type your identification on the same lines as the LOGIN command and to follow it with a carriage-return. For example,

. LOG 6100, 2500

PASSWORD:

The LOGIN program needs one more item to complete its analysis of your identification. This it requires in the next line by asking for a password.

Type in the password, which is assigned by the University Computer Center, followed by a carriage-return. To maintain

password security, the LOGIN program does not print the password.

If the identification typed in matches the identification stored in the accounting file in the monitor, the LOGIN program signifies its acceptance by responding with the time, date, day of the week, the message of the day (if any), and a period.

For example,

```
U OF ARIZONA 2:50 P.M. MON AUG 25  
JOB 57 TTY74 USER FOSTER K  
BALANCE=346.05
```

MESSAGE

.

This typeout indicates that the LOGIN program has exited and returned control to the monitor. You have successfully logged in and may now have the monitor call in other programs for you. Once logged on, it is good practice to record your user number (ie, 57 in the above example) for possible future reference. Its use will be explained later. If the identification typed in does not match the identification in the accounting file, the monitor types out the error message.

? INVALID ENTRY-TRY AGAIN

#

If this error message occurs, type in the correct project programmer numbers and password.

## Step 2: Computer Assisted Instructions on the Use of AWIS

Prior to entry into the data retrieval phase of AWIS you may want to seek additional information about what files are on AWIS, where the data originated, what the file contains, and special information needed to access data within the file.

In order to utilize the computer assisted instruction after the LOGIN procedure has been performed, type in the following sequence to the terminal. Terminal response is again underlined as shown below:

```
R BASIC
READY, FOR HELP TYPE HELP
OLD
OLD FILE NAME--
AWC
READY
RUN
```

A short delay may occur before the computer-assisted instructions are initiated, depending on the computer load from other users. From this point in the instruction phase, the user should follow instructions presented on the terminal display.

Upon entry to the computer-assisted instruction for AWIS, the user will be greeted by the following message:

```
"Welcome to the University of Arizona's
Arizona Water Information System (AWIS). The
language developed for user access to the
AWIS has been developed with the user in mind
and requires little or no prior computer
knowledge. If you are unfamiliar with the use
of AWIS simply utilize the HELP command."
```

## Command Definitions

### HELP COMMAND

The HELP COMMAND is simply a listing of all other commands the instructional program recognizes. It does not explain the purpose of each command. This is done by typing the command desired. Upon typing the word HELP, the system will respond with the following information:

Recognized commands are as follows:

```
HELP
FILES
DISPLAY
CODES
```

An explanation for each of the above commands is given below as it would appear on the terminal after typing that command.

### FILES COMMAND

By typing the word FILES, the user will be supplied with a brief overview of the type of hydrologic information within each file and its contributor. For example, after typing the word FILES, the terminal will respond with the following information:

```
FILE NAME --- TWN
CONTRIBUTOR---Arizona Water Commission
SUMMARY---File contains statewide groundwater infor-
            mation by quarter township.
FILE NAME --- BSN
CONTRIBUTOR --- Arizona Water Commission
SUMMARY --- File contains statewide information on
            groundwater in storage and groundwater
            pumped in 1971 by river basin.
```

### DISPLAY COMMAND

By typing the word DISPLAY, the terminal will respond with

the message FILE NAME-. The user then supplies the three-letter code name for the file for which he would like additional information. All files currently residing on AWIS can be listed by using the FILES command previously explained. Following is an example of the information obtainable by typing either TWN or BSN.

FILE NAME - TWN

By typing TWN after terminal response FILE NAME-, the terminal will respond with the following information:

The file TWN contains 16 items of information for each quarter township within the entire state of Arizona. The information was supplied by AWC which is not collecting primary water data, but is using water data from other sources (and providing some supplemental information whenever possible) to prepare reports and maps describing Arizona's groundwater. The following kinds of water information are examined comprehensively (state-wide) on a general level of detail, but not intensively in the TWN file.

- a. quality
- b. level
- c. potential well production

The information stored within AWIS has been taken from two maps developed by AWC. These are:

- 1) "Potential Well Production, Water Service Elevations and Direction of Groundwater Flow in Arizona."
- 2) "Quality of Groundwater, Changes in Water Levels, Amounts of Groundwater in Storage, and Groundwater Pumpage in Arizona."

The following table gives the item description and item number of data for each quarter township on file.

ITEM DESCRIPTION	ITEM NUMBER
Computer code number	*1
Township	*2
Range	*3
Quarter township	*4
Section	*5
Quarter section	*6
Basin	*7
County	*8
Potential well production (gpm)	*9
Surface water elevation (ft. above sea level)	*10
Depth to water table (ft. below land surface-contour)	*11
Depth to water (ft. below land surface-point)	*12
Dry well at indicated depth	*13
Water level change	*14
Period of change	*15
Dissolved solids	*16
Specific conductance (micromhos @ 25 C)	*17

FILE NAME --- BSN

By typing BSN after terminal response FILE NAME-, the terminal will respond with the following information:

The file BSN contains 6 items of information for each AWC-designated river basin in Arizona (see page 11, Explanation of Coded Items for river basin names). The information was supplied by AWC, which is not collecting primary water data from other sources (and providing some supplemental information whenever possible) to prepare reports and maps describing Arizona's

groundwater. The following kinds of information are examined comprehensively (statewide) on a general level of detail, but not intensively.

- a. storage amount
- b. pumpage
- c. worth of data

The information stored within AWIS has been taken from two maps developed by AWC. These are:

"Potential Well Production, Water Service Elevation, and Direction of Groundwater Flow in Arizona."

"Quality in Groundwater, Changes in Water Levels, Maps of Groundwater and Storage, and Groundwater Pumpage in Arizona."

The following table gives the item description and item number for each river basin on file.

ITEM DESCRIPTION	ITEM NUMBER
Computer code number	*1
Basin	*2
Groundwater in storage to 1200 ft. below surface (ac.ft. x 1000)	*3
Groundwater pumped since basin development (ac.ft. x 1000)	*4
Amount pumped in 1971 (ac.ft. x 1000)	*5
Worth of data	*6

#### CODES COMMAND

Upon typing the command CODES, the computer terminal will respond with the message FILE NAME-, and the user provides the three-letter code for the particular file of interest, for example TWN or BSN.

Referring back to the 17 items of information given for the township file (TWN) as shown under the DISPLAY command, file creation requires that for each item number and item description a unique piece of data or numerical information is placed into the computer. Many times it is more convenient on data input to represent the information within the file by a numeric or alphanumeric code. For example, Item 7, Basin, can be input by a three-letter code which designates all unique river basins in Arizona. The Douglas Basin is represented by the three-letter code DOU and the Avra Valley Basin is represented by the three-letter code AVR. Thus, input to the information system can be accomplished using a code as a data item, hence the retrieval must also be made utilizing the same code.

#### Explanation of Coded Items for TWN File

By typing TWN after terminal response FILE NAME-, the terminal will respond with the following information:

The file TWN has 6 coded items. They are Items \*4, quarter township; \*7, basin; \*8, county; \*9, potential well production; \*16, dissolved solids; and \*17, specific conductance. To learn the codes associated with the data contained within these items, type the item number (e.g. \*4) following the terminal message CODE NUMBER-. In review the user-terminal sequence for the CODES command is as follows:

COMMAND? CODES

FILE NAME- TWN

CODE NUMBER- \*4,\*7,\*9,\*16, or \*17 (supply only one code number at a time)

Explanation of Coded Item \*4-QUARTER TOWNSHIP

Each township within the state is divided into equal quarters. These are the northeast 1/4, the northwest 1/4, southwest 1/4, southeast 1/4. The numeric codes assigned for each quarter section are given below:

<u>NUMERIC CODE</u>	<u>EXPLANATION</u>
1	northeast 1/4
2	northwest 1/4
3	southwest 1/4
4	southeast 1/4

Explanation of Coded Item \*7-BASIN

<u>ALPHA CODE</u>	<u>EXPLANATION</u>
AGF	Agua Fria Basin
ALT	Altar Valley
ARA	Aravaipa Valley
AVR	Avra Valley
BIC	Big Chino Valley
BIS	Big Sandy Valley
BWM	Bill Williams Area
BLM	Black Mesa Area
BRB	Black River Basin
BOD	Bodaya Mesa Area
BUT	Butler Valley
CDI	Canyon Diablo Area
CHV	Chevron Area
CHN	Chinle Valley
COP	Coconino Plateau
CON	Concho Area
CHI	Colorado River Hoover Dam to Imperial Dam
DOU	Douglas Basin
DUN	Duncan Basin
GIL	Gila Bend Area
GRD	Gila Bend Drainage from Painted Rock to Texas Hill
GSK	Gila River from Head of San Carlos Reservoir to Kelvin
GTD	Gila River-Texas Hill to Dome
GWA	Grande Wash Area
GWA	Grande Wash Area

<u>ALPHA CODE</u>	<u>EXPLANATION</u>
HAR	Harquahala Plains Area
HAS	Hassayampa Basin
HOL	Holbrook Area
HOP	Hopi Area
HOU	Houserock Valley Area
HUA	Hualapai Valley
KAI	Kaibito Plateau Area
KAN	Kanab Area
LIC	Little Chino Valley
LHA	Lower Hassauampa-Tonopah Basin
LSP	Lower San Pedro Basin
LSC	Lower Santa Cruz Basin
MMU	McMullen Valley
MNV	Monument Valley
NLC	New River-Cave Creek Area
PSC	Peach Springs Canyon
PRZ	Puerco-Zuni Area
RAN	Ranegras Area
SAC	Sacramento Valley
SAF	Safford Basin
SRV	Salt River Valley
SBV	San Bernadino Valley
SFP	San Francisco Peaks Area
SFR	San Francisco River Basin
SSI	San Simon Basin
SSW	San Simaon Wash
SHV	Shivwits Plateau Area
STJ	St. Johns Area
SNO	Snowflake Area

<u>ALPHA CODE</u>	<u>EXPLANATION</u>
TON	Tonto Basin
TUB	Tuba City Area
USR	Upper Salt River Basin
USP	Upper San Pedro Basin
USC	Upper Santa Cruz Basin
VER	Verde Valley
VRG	Virgin River
WAT	Waterman Wash
WMD	Western Mexican Drainage
WHM	White Mountains
WRB	White River Basin
WIL	Willcox Basin
WMN	Williamson Valley
YUM	Yuma Area

Explanation of Coded Number \*8-COUNTY

<u>NUMERIC CODE NUMBER</u>	<u>COUNTY</u>
1	Apache
2	Cochise
3	Coconino
4	Gila
5	Graham
6	Greenlee
7	Maricopa
8	Mohave
9	Navajo
10	Pima
11	Pinal
12	Santa Cruz
13	Yavapai
14	Yuma

Explanation of Coded Number \*9-POTENTIAL WELL PRODUCTION (gpm)

<u>NUMERIC CODE NUMBER</u>	<u>POTENTIAL WELL PRODUCTION (gpm)</u>
1	50 to 2500
2	10 to 50
3	0 to 10
4	Dry, Poor Quality or Insufficient Data

Explanation of Coded Item Number \*16-DISSOLVED SOLIDS (mg/l)

<u>NUMERIC CODE NUMBER</u>	<u>DISSOLVED SOLIDS (mg/l)</u>
1	less than 1000
2	1000 to 3000
3	more than 3000

Explanation of Coded Item Number \*17-Specific Conductance  
(micromhos @ 25°C)

<u>NUMERIC CODE NUMBER</u>	<u>SPECIFIC CONDUCTANCE</u>
1	1700
2	1700-5000
3	5000
4	

Explanation of Coded Items for BSN File

The file BSN has 3 coded items. They are Items \*2, basin; \*6, worth of data; and \*7, bibliographic references. To learn the codes associated with the data contained within these items type the item number (eg. \*2), following the terminal message CODE NUMBER-. In review the user-terminal sequence for the CODES command is as follows:

```
COMMAND? CODES  
FILE NAME- BSN  
CODE NUMBER- *2,*6, or *7 (supply only one code  
number at a time)
```

Explanation of Coded Item \*2-BASIN

Alpha codes for item 2 in the BSN file correspond to the codes given in the TWN file for item 7. Reference must be made back to item 7 for explanation.

Explanation of Coded Item \*6-WORTH OF DATA

<u>NUMERIC CODE</u>	<u>EXPLANATION</u>
1	Data recent and of good quality
2	Data old but good quality
3	Data recent but of questionable quality
4	Data old and of questionable quality
5	Data sparse - map largely inferred

Step 3: Retrieval

The retrieval phase of AWIS allows the user two options or modes of retrieval. Mode 1 is a simplistic retrieval approach

designed for the structured retrieval of data on a range, township basis. This mode is intended for ease of system-use by lay users desiring information on a geographic basis. Mode 2 allows for the query of the files in a scientific format whereby any combination of criteria can be placed on each or all data items.

The retrieval phase is for interrogating the previously explained data files and is executed after the Logon procedures and computer-assisted instructions by typing the command RU RETR. In a Retrieval phase, each element in the file is examined and subjected to retrieval criteria. If the criteria are satisfied, those items (or others specified) may be extracted from the element.

Interrogation involves the user providing the mode number (1 or 2) when the system types Mode and file (three-letter code) name when the system types File?

#### Mode 1 Explanation

After typing 1 for the Simplistic mode and providing the file name TWN, the system currently replies with the following information: Specify Township, Range, and Quarter Township for area in which you desire information upon computer command.

Township? (for example 13S)

Range ? (for example 14E)

Quarter township? (supply numbers 1,2,3 or 4 for NE1/4, NW1/4, SW1/4, and SE 1/4 respectively).

The AWIS may tell you the following information regarding your area of interest:

<u>ITEM DESCRIPTION</u>	<u>ITEM NUMBER</u>
Basin	7
County	8
Potential well production (gpm)	9
Surface water elevation(feet above sea level)	10
Depth to water table (feet below land surface-contour)	11
Depth to water table (feet below land surface-point)	12
Dry well at indicated depth	13
Water level change	14
Period of change	15
Dissolved solids	16
Specific conductance (micromhos @ 25 c)	17

Indicate which items you wish retrieved by typing the corresponding item numbers. For example 14, 15 will provide the water level change and period of change for your specified area.

#### Mode 2 Explanation

After typing 2 for the Scientific mode, and providing the file name, the system responds with a hyphen or dash (-) to

indicate its readiness to retrieve information stored within the file choice.

Retrieval Criteria - The dash(-) indicates to the user that the succeeding string of characters must specify a set of retrieval criteria.

Retrieval Criteria Terminology - Retrieval facilities available to the user range from logically simple to rather complex. The terminology used in describing retrieval criteria is introduced in the following two subsections.

Item Sub-Criterion (1.0) - This is a single condition which may be applied to any item in an element. A combination of one or more sub-criteria defines a criterion.

Relational Sub-Criterion. A relational sub-criterion consists of a quillifier (indicating the item to be examined, eg.,\*4), followed by one of the relational operators listed below and finally an external value (comparison value presented by user).

EQ equals

NE does not equal

GT is greater than

LT is less than

GE is greater than or equal to

LE is less than or equal to

For multiple items, a relational sub-criterion is imposed on one or more of the sub-items or on all the sub-items at once. For example \*4 EQ 1.

Retrieval  
Criterion (2.0)

A retrieval criterion is a set of item criteria. If there are no AND, OR connectors between them, all are assumed to be joined by the connector AND. Thus, the set of item criteria must be true for the appropriate action - Extraction to take place. For example \*4 EQ1 and \*7 EQ ALT.

External Value -

An external value presented in a criterion is compared with the item value in the file. The type (alpha, numeric, coded) of the external value in a relational sub-criterion must be the same as the type of the item on which the criterion is imposed.

The external value in a sub-criterion on a numeric or date item must fulfill the same input requirements as specified for its corresponding item.

The external value in a sub-criterion on a coded item must be in acceptable code form. With an alphanumeric item, there are no restrictions.

Example: \*2 EQ 13S and \*3 EQ 14E or \*15E EQ 300.

Summary: -  
Simple Relational  
Criteria

Before a relational criterion on an item is evaluated, a check is made by the system to ensure that the item value exists. This is, in effect, an implicit existence criterion; It is not normally necessary for the user to specify it. If the item does not exist in the element, the relational criterion fails for that element.

Logical  
Connectors -

When several sub-criteria are imposed on an item, they are joined by the logical connectors AND or OR.

Examples: \*7 EQ AVR OR EQ LSC

AND, OR connectors may also be used between item criteria referring to different items.

Example: \*2EQ13S AND \*3EQ14E

If connectors do not occur between successive item criteria AND is assumed.

Retrival  
Phase -

After the retrieval criteria has been provided, the system will again respond with a dash (-). This indicates the system now expects instructions regarding which items the user desires retrieved, assuming the retrieval criteria has been met. Two instructions are acceptable. They are, for example, REPORT ALL or REPORT 2,3,4. The first instruction provides all information on file, for each record matching the specified criteria. The second instruction allows for the selective reporting of only those items desired. In the above example, only items 2,3, and 4 are printed.

System  
Shutdown -

Upon completion of all desired retrievals, the user must type the letter S following the dash (-). This is a message to the system that all desired retrievals have been made. The system will respond with END OF EXECUTION.

#### TERMINAL USE HINTS

Logging off -

To logoff the terminal, type K/F and wait for terminal response.

Program detached -

If for any reason you lose the telephone link (hang up, cut off, etc.) while logged on, perform the following steps:

- 1) Redial phone number-884-4141
- 2) Type ATTACH User number(6100,2500)
- 3) The terminal will again ask for your password. Your user number was given when you logged on as explained in Step 1: Getting on the System.