nawdex

NATIONAL WATER DATA EXCHANGE

FIRST MEMBERSHIP CONFERENCE OF THE NATIONAL WATER DATA EXCHANGE MAY 9-11, 1978, DENVER, COLORADO

PROCEEDINGS

U.S. GEOLOGICAL SURVEY
Open-File Report 79—206

PROCEEDINGS OF THE FIRST MEMBERSHIP CONFERENCE OF THE NATIONAL WATER DATA EXCHANGE, MAY 9-11, 1978, DENVER, COLORADO

Compiled by Beverly M. Myers and Janet M. Nokes

U.S. GEOLOGICAL SURVEY
Open-File Report 79—206

1979

UNITED STATES DEPARTMENT OF THE INTERIOR
CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY
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PREFACE

The National Water Data Exchange (NAWDEX) is a national confederation of water-oriented organizations working together to improve access to water data. NAWDEX held its first membership conference in Denver, Colorado, on May 9-11, 1978. The purpose of the conference was to acquaint participants in the NAWDEX program with systems, data resources, and services available throughout the membership, to establish improved personal relationships within the membership, and to serve as a forum for the exchange of ideas and expertise on matters relating to improving the operation of NAWDEX and identifying the needs of the water-data community. A copy of the conference agenda is contained in appendix A. There were 84 registered participants, representing 46 organizations, registered at the conference. This included representatives of 33 NAWDEX member organizations and 13 observer organizations. A complete list of attendees is contained in appendix B.

Sixteen papers were presented at the conference describing data systems of member organizations, needs of the data community, and programs of national interest. These papers are presented in their entirety in the following proceedings. An extensive exhibit of many of the systems discussed was also conducted throughout the conference. A list of these exhibitors and systems displayed is given as part of appendix A. Four working panels were also conducted dealing with: (1) Program Administration, Management, and Coordination; (2) Recommended Standards for the Handling and Exchange of Water Data; (3) Water Data Indexing and Technical Systems Development; and (4) Request, Response, and Service Activities. The reports and conclusions of these panels are also included in the proceedings.

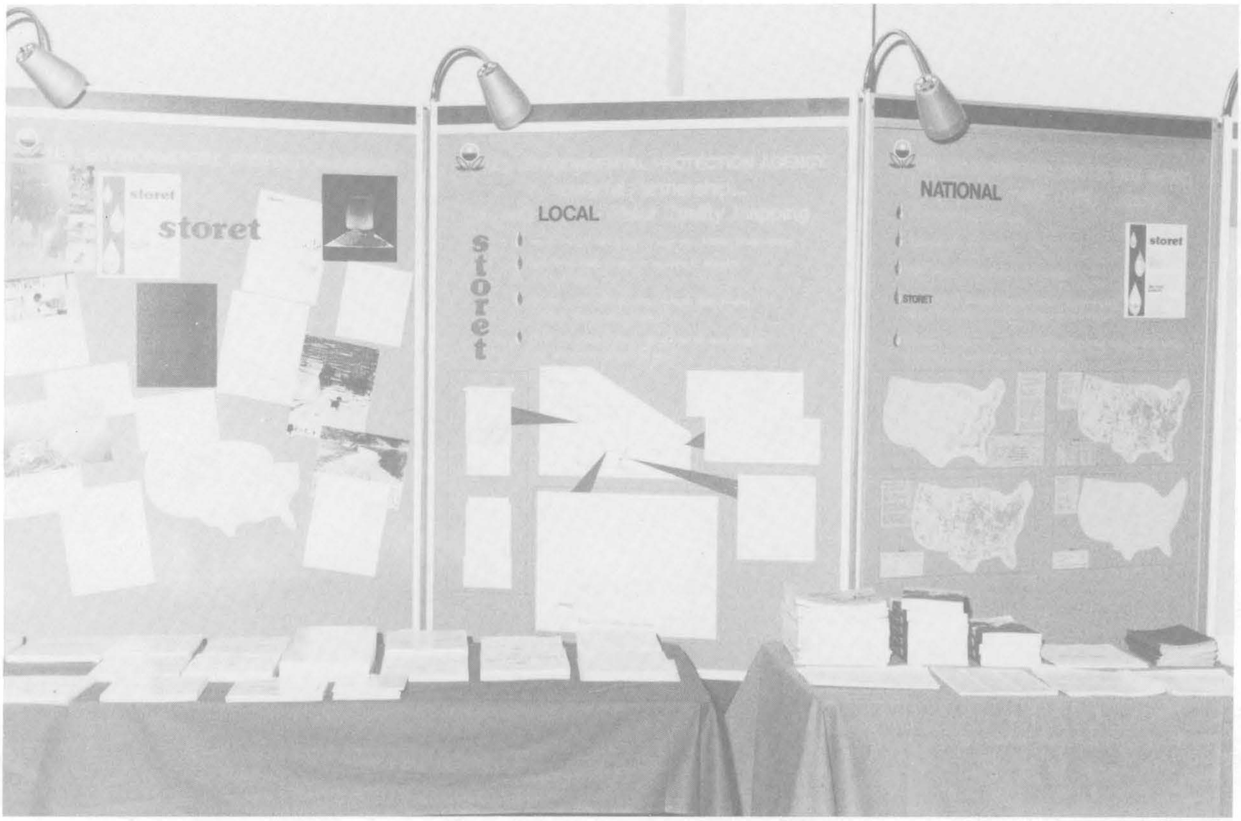
The conference was considered a success and will serve as a good framework for future conferences scheduled to be held annually. As the NAWDEX membership expands, these conferences will become more important in helping to improve communication throughout all sectors of the water-resources and environmental community.

SI UNITS AND INCH-POUND SYSTEM EQUIVALENTS

[SI, International System of Units, a modernized metric system of measurement. All values have been rounded to four significant digits except 0.01 bar, which is the exact equivalent of 1 kPa. Use of hectare (ha) as an alternative name for square hectometer (hm^2) is restricted to measurement of land or water areas. Use of liter (L) as a special name for cubic decimeter (dm^3) is restricted to the measurement of liquids and gases; no prefix other than milli should be used with liter. Metric ton (t) as a name for megagram (Mg) should be restricted to commercial usage, and no prefixes should be used with it. Note that the style of meter^2 rather than square meter has been used for convenience in finding units in this table. Where the units are spelled out in text, Survey style is to use square meter]

SI unit		U.S. customary equivalent	
Length			
millimeter (mm)	=	0.039 37	inch (in)
meter (m)	=	3.281	feet (ft)
	=	1.094	yards (yd)
kilometer (km)	=	0.621 4	mile (mi)
	=	0.540 0	mile, nautical (nmi)
Area			
centimeter^2 (cm^2)	=	0.155 0	inch^2 (in^2)
meter^2 (m^2)	=	10.76	feet^2 (ft^2)
	=	1.196	yards^2 (yd^2)
	=	0.000 247 1	acre
hectometer^2 (hm^2)	=	2.471	acres
	=	0.003 861	section (640 acres or 1 mi^2)
kilometer^2 (km^2)	=	0.386 1	mile^2 (mi^2)
Volume			
centimeter^3 (cm^3)	=	0.061 02	inch^3 (in^3)
decimeter^3 (dm^3)	=	61.02	inches^3 (in^3)
	=	2.113	pints (pt)
	=	1.057	quarts (qt)
	=	0.264 2	gallon (gal)
	=	0.035 31	foot^3 (ft^3)
meter^3 (m^3)	=	35.31	feet^3 (ft^3)
	=	1.308	yards^3 (yd^3)
	=	264.2	gallons (gal)
	=	6.290	barrels (bbl) (petroleum, 1 bbl=42 gal)
	=	0.000 810 7	acre-foot (acre-ft)
hectometer^3 (hm^3)	=	810.7	acre-feet (acre-ft)
kilometer^3 (km^3)	=	0.239 9	mile^3 (mi^3)
Volume per unit time (includes flow)			
decimeter^3 per second (dm^3/s)	=	0.035 31	foot^3 per second (ft^3/s)
	=	2.119	feet^3 per minute (ft^3/min)

SI unit		U.S. customary equivalent	
Volume per unit time (includes flow)—Continued			
decimeter^3 per second (dm^3/s)	=	15.85	gallons per minute (gal/min)
	=	543.4	barrels per day (bbl/d) (petroleum, 1 bbl=42 gal)
meter^3 per second (m^3/s)	=	35.31	feet^3 per second (ft^3/s)
	=	15 850	gallons per minute (gal/min)
Mass			
gram (g)	=	0.035 27	ounce avoirdupois (oz avdp)
kilogram (kg)	=	2.205	pounds avoirdupois (lb avdp)
megagram (Mg)	=	1.102	tons, short (2 000 lb)
	=	0.984 2	ton, long (2 240 lb)
Mass per unit volume (includes density)			
kilogram per meter^3 (kg/m^3)	=	0.062 43	pound per foot^3 (lb/ft^3)
Pressure			
kilopascal (kPa)	=	0.145 0	pound-force per inch^2 (lbf/in^2)
	=	0.009 869	atmosphere, standard (atm)
	=	0.01	bar
	=	0.296 1	inch of mercury at 60°F (in Hg)
Temperature			
temp kelvin (K)	=	[temp deg Fahrenheit (°F) +459.67]/1.8	
temp deg Celsius (°C)	=	[temp deg Fahrenheit (°F) −32]/1.8	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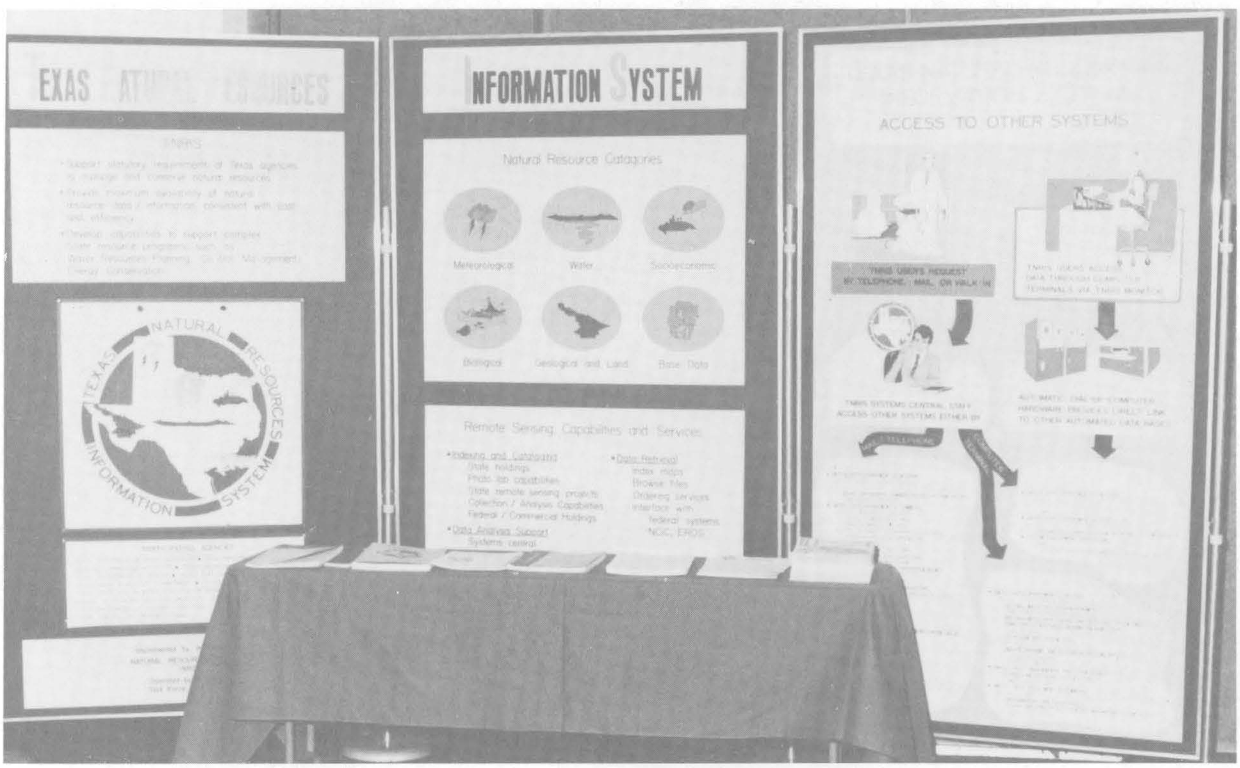
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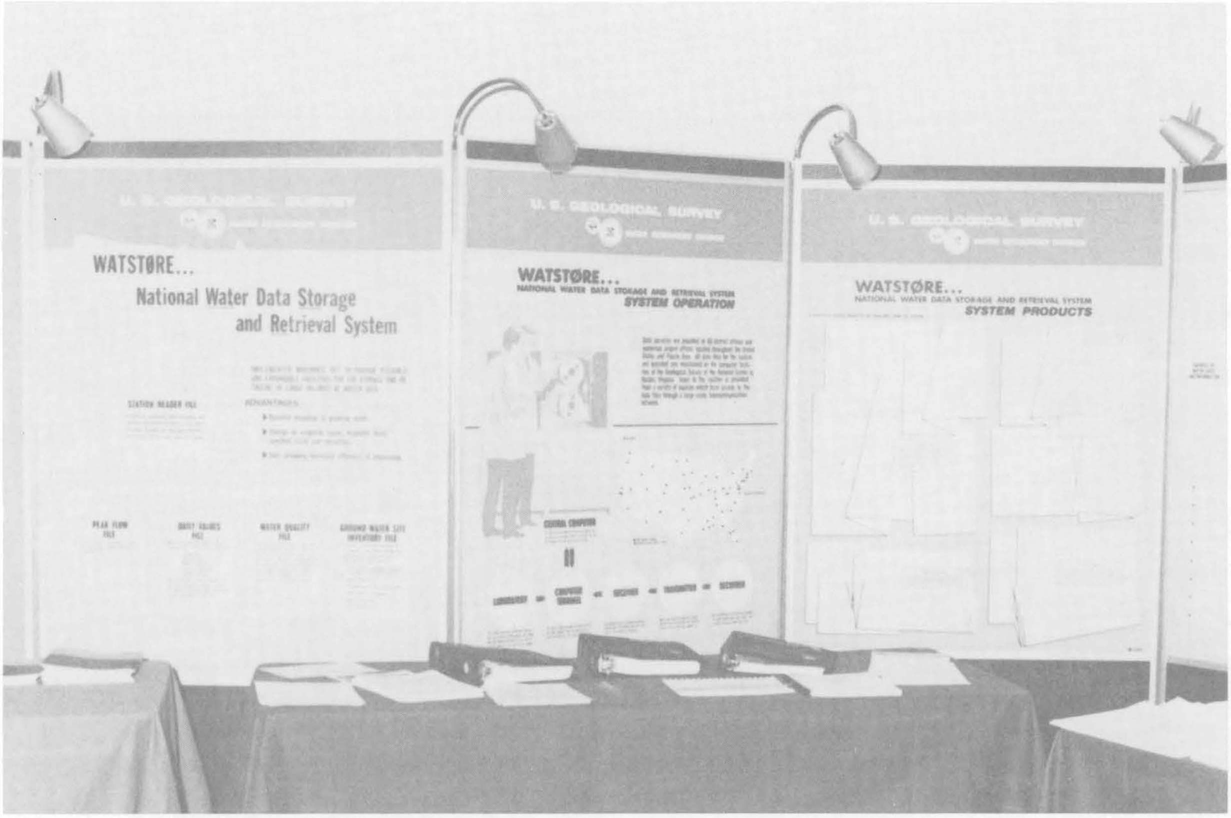
U. S. GEOLOGICAL SURVEY
WATSTØRE...
National Water Data Storage and Retrieval System
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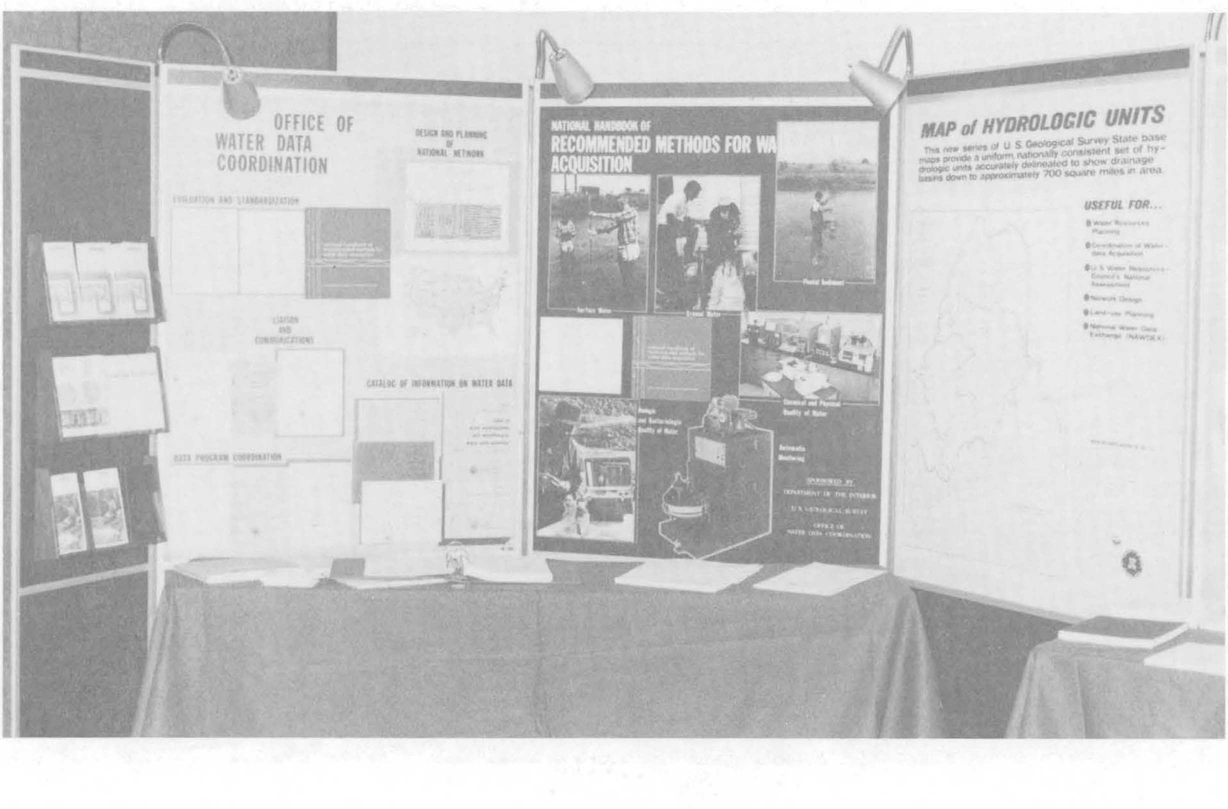
OFFICE OF WATER DATA COORDINATION
DESIGN AND PLANNING OF NATIONAL NETWORK
EVALUATION AND STANDARDIZATION
CATALOG OF INFORMATION ON WATER DATA
DATA PROGRAM COORDINATION
NATIONAL HANDBOOK OF
RECOMMENDED METHODS FOR WA
ACQUISITION
MAP of HYDROLOGIC UNITS
This new series of U.S. Geological Survey State base maps provide a uniform, nationally consistent set of hydrologic units accurately delineated to show drainage basins down to approximately 700 square miles in area.
USEFUL FOR...

CONTENTS

OPENING REMARKS AND INTRODUCTION OF KEYNOTE SPEAKER

By S. M. Lang, Chairman [1/]

Good morning ladies and gentlemen. Welcome to Denver and to the first NAWDEX membership conference. We are looking forward to a very interesting session. I hope you will take advantage of the opportunity to review the exhibits in the next room. Also, the documents that are in the display case in the middle of the room contain some of the earlier results of the NAWDEX interagency work group meetings. One in particular describes the design characteristics for NAWDEX. That is the basic document that was used to guide the development of the system to its current form. The reason I call your attention to it is that I think you will be surprised as to how well we have been able to incorporate the basic design characteristics in the development of the system.

There also are two additional publications in the central display unit, written by our first contractor, the PRC Systems Sciences Company, which describe the early design and implementation plans for NAWDEX. The results of two separate contracts are in these documents. Again, I think you will be able to note how the evolution of NAWDEX has followed closely those initial implementation plans.

As you probably know, NAWDEX is now approximately 2 years old, and we are rather proud of the strides that have been made in the development of the system. Much of the success is due to the cooperation of people like you. We have a rather large membership. I do not intend to go into any detailed discussion at this time because I know Doug Edwards and several others, who will be speaking later, will go into the fine points. However, we do have reason to be proud of the success that we have had to date in the growth of the system.

We have a rather extensive program today for presentation and Doug, during his coverage of the so-called housekeeping affairs, will go into more detail on that.

The program does describe the data activities of other agencies participating in NAWDEX, and if you will look at your agenda, you will note that we are giving our sister agencies the opportunity to describe their programs and allow some time for discussion of their capabilities in the area of data dissemination.

We will be preparing a proceedings volume of this meeting and much of the material that has been handed out will be included in the publication,

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[1/] Acting Assistant Chief Hydrologist for Scientific Publications and Data Management, U.S. Geological Survey, Reston, Va.

although it may be in a slightly different format. We hope that, during the meeting today, you will take the opportunity to ask questions and to take part in the general discussions.

With that, I would like to get into the program, and the first item on the program is the keynote address by Joe Cragwall.

Joe has served as Chief Hydrologist of the Geological Survey, Water Resources Division, since 1974. Prior to that time, he held positions as Assistant Director for Programs, Assistant Chief Hydrologist for Operations, and he was a Staff Assistant for Planning, in the Office of the Under-Secretary. Prior to that he was the District Chief for the Division, in the State of Tennessee.

Joe holds a degree in civil engineering from the University of Virginia, and is also a graduate of the Federal Executive Institute. He is a Registered Professional Engineer in the State of Virginia and a fellow of the American Society of Civil Engineers. He is also a member of the National Society of Professional Engineers; the American Geophysical Union; the Geological Society of America; and the American Water Resources Association.

It is my pleasure to present Joe Cragwall.

KEYNOTE ADDRESS

WATER DATA - A VALUABLE RESOURCE

By J. S. Cragwall, Jr.[1/]

I would like to add my welcome to the attendees here today. It is especially pleasing to have the participation of not only the other Federal agencies, but many of the State agencies and other institutions as well. I look upon this conference as a "milestone" occasion because it represents the culmination of a long, and at times, arduous period of development for this interagency activity that we call NAWDEX. Our being here proves that NAWDEX is operational and ready to meet the needs of the water-data user community for improved information service. I look forward to seeing NAWDEX continue to improve as a viable and responsive program in which we can all participate with pride and in a unified fashion. This conference is an important step in reviewing what we have done to date and in assessing what we need to do.

Each of us here today is either a collector of water data, a user of water data, or both. We are keenly aware of the growing value of water data and, thus, the need for careful selection of the collection sites and the suite of parameters to meet current as well as future data requirements. The demands for data are constantly growing and the uses of these data are becoming more diverse. We only need to look at the impact of the energy problem of the last few years, and the impact of the National Environmental Policy Act as two outstanding examples of the increasing diversity of the demand for water resources information. We, who are collectors of water data, are challenged to make these valuable information resources readily available and in such forms as to be most useful to the user community.

The goals and concepts of NAWDEX are designed to meet this challenge. The system's resources are growing rapidly, thereby allowing us to do a better job of providing data services. A nationwide network of assistance centers helps us to provide convenient access to information and to more readily provide the necessary linkages between the data users and the data holders. The organizational concept of NAWDEX, whereby we all work together as members, helps us to make better use of the resources and expertise available from each of our organizations. This can only help to improve our indexing and data exchange processes nationwide. Also, NAWDEX provides a viable linkage and support mechanism for constructive participation from organizations of all sizes, from large, nationally oriented Federal programs, to small, local agencies and even individuals. NAWDEX has already improved our communication channels and represents a major step forward in improving the interaction between data collectors and data users.

[1/] Chief Hydrologist, U.S. Geological Survey, Reston, Va.

To better focus upon the need for and potential services that can be rendered by a public function like NAWDEX, perhaps it would help to set the stage of this conference to look at just part of the Federal water data activity. I want to go through this not as an address from the Geological Survey, but to give some figures to show what size of operation we are dealing with, which I think is impressive.

The Federal agency I represent, the Geological Survey, is responsible for appraising the source, quantity, and quality of the Nation's water resources. It also has the lead agency responsibility for coordinating the activities of all Federal agencies in the acquisition of water data on streams, lakes, reservoirs, estuaries, and ground waters. During Fiscal Year 1978, our Water Resources Division will expend about $150 million in responding to these responsibilities. These funds support studies of critical national water problems in our Federal programs, resources evaluations and data acquisition activities in our cooperative programs with nearly 600 State and local governmental agencies, and work performed, of a specific nature, for more than 20 other Federal agencies involved with water missions. Forty-five percent of the funds are directed at the collection, analysis, and dissemination of streamflow, water-quality, ground-water, and sediment data; 23 percent for areal, analytical, predictive, and interpretive resource studies; 19 percent for studies related to critical water problems; and 13 percent for supportive research and development and other data-collection functions such as administration of interstate compacts.

As a part of our National Water Data System, the Geological Survey measures daily streamflows at nearly 8,000 sites, partial flow at nearly 8,000 sites, water quality at over 5,000 sites, sediment at over 1,200 sites, and, in a typical year, water levels and quality at 22,000-25,000 wells. This year, our central laboratories will analyze more than 150,000 water samples for a suite of over 200 constituents ranging from simple, inorganic compounds to complex organic structures, biological species, and radiochemical substances. These data, for the most part, are stored in computerized form in our National Water Data Storage and Retrieval system (WATSTORE) for subsequent use and dissemination. In addition, we annually publish these data in 68 data volumes which are made available to our users. We also produce annually over 800 reports and hydrologic atlases related to interpretative studies, the results of research, and techniques and methodology for investigating water resources.

In regard to critical energy and environmental problems I mentioned earlier, studies are being made in the areas of coal hydrology, oil-shale hydrology, nuclear hydrology, subsurface waste storage, geothermal energy, underground heat storage, ground-water recharge, flood hazard mapping, and estuarine and coastal zone work. This year, we are implementing a series of digital model studies of the regional aquifer systems of the United States. Three such studies are being initiated--in the Northern Great Plains, the High Plains, and the Central Valley of California. We intend to start three more major studies in Fiscal Year 1979. We are in the process of developing and implementing a National Water Use Data System (NWUDS) as a part of our Federal-State cooperative program. Fifteen States are involved initially in this program and eventually all the States will be linked together in a system which will provide important information for improved conservation and management of our water resources. I might mention that the fields of urban hydrology and coastal hydrology are looming as additional, very highly important areas which will impact upon the data bases that are handled by members of NAWDEX.

These programs demonstrate the magnitude of our data-collection activities. Add to this the data being collected by other Federal, State, and local government agencies, and private organizations, and it amounts to a massive amount of data to be managed and to be made available to people.

My agency is also deeply involved in coordinating the acquisition and dissemination of water data. In 1964, we were assigned the responsibility for implementing the provisions of Circular A-67, issued by the Office of Management and Budget, and directed at improving water-data acquisition within the Federal community. The Office of Water Data Coordination was established at that time to develop and direct this activity. More details on the OWDC and water-data coordination will be presented to you by Hal Langford who follows me on the program. The Geological Survey has two advisory committees that aid in its coordination role under Circular A-67: the Federal Interagency Advisory Committee on Water Data and the non-Federal Advisory Committee on Water Data for Public Use. I am pleased to serve as chairman of the first Committee and as alternate chairman of the second. These committees have made valuable contributions to the coordination effort. One important contribution was the establishment of the Federal Interagency Water Data Handling Work Group, in 1970, as a task group of the Interagency Advisory Committee on Water Data. This work group developed and presented the design characteristics of the National Water Data Exchange in 1971 and recommended that NAWDEX be established. This recommendation was subsequently endorsed by both advisory committees. NAWDEX clearly supports the responsibilities of Circular A-67 as related to the cataloging of data-acquisition activities and facilitating the exchange of data between agencies.

The Geological Survey is pleased to have a lead role in the implementation of NAWDEX. We believe that NAWDEX can help us to improve data dissemination, to inform others of the availability of data, and to assist them in getting it promptly and at low cost. As a means of bringing the benefits of NAWDEX to the local level, we have designated each of our 46 district offices and several major subdistrict offices as Local Assistance Centers. We have also opened the files of our WATSTORE system for direct access to a limited number of large users. We also have benefitted from our NAWDEX activities by having a centralized index and inventory of our data resources. NAWDEX gave us the motivation to get that done. Information about our data-collection activities is being made readily available for program management and development to more than 50 offices that are equipped with computer terminals. The Survey contributes water quality data on a continuing basis to the Storage and Retrieval System (STORET) of the U.S. Environmental Protection Agency, thereby enlarging the opportunity for usefulness of these data. We require that each report prepared in our Water Resources Division be cited and abstracted in the Water Resources Scientific Information Center of the Department of the Interior, thus, making these reports known to a wider audience. I am pleased that each of these systems is a participating member of NAWDEX, and is making a significant contribution to the objectives of NAWDEX. Also, we now release our annual basic-data publications through the National Technical Information Service of the U.S. Department of Commerce, thereby expanding their availability to the user community. Through NAWDEX and all these systems, including many that I have not mentioned, our data and information about our products are more readily available to those who require them. We will continue to seek more effective means of disseminating our data and the results of our investigative programs through our involvement with NAWDEX.

Your attendance at this conference demonstrates that you, too, place a high value on water data; not only monetarily but also the great value realized by improved cooperation and communication within the scientific community. The value of water data will increase as data-collection costs increase, as the problems and need for protecting our environment become more severe, as the need to develop our energy resources continues to grow, and as overall competition for our available water resources increases. Your attendance also indicates a mutual interest in improving NAWDEX capabilities for data indexing, exchange, and utilization.

The more that people make use of a piece of data, the more cost-effective it becomes. NAWDEX can improve that cost effectiveness. As more organizations lend their support to NAWDEX, the more efficient and viable the program will become, thereby, providing greater benefit to all of us. For the first time, we have a national-level program that directs its full attention to improving data exchange processes. By working together, we can continue to improve these capabilities to place our valuable data resources in the hands of those who need them, when they need them, and in a form that is most useful.

I am pleased to have a role in opening this first conference of the NAWDEX membership. I have looked at the agenda and I am impressed by the amount of work you are hoping to accomplish. I am also pleased to see a multiplicity of participation and leadership in your work groups. I think the work group approach is a good one. I do not think people like to come to a meeting like this one and just sit and listen to talks; they want to roll up their sleeves and do some work. I take this opportunity to wish you a successful and productive session, and to assure you of the continued support of the Geological Survey for the NAWDEX program.

WATER DATA COORDINATION AND THE ROLE OF NAWDEX

By R. H. Langford[1]

My topic for discussion today is the role that the National Water Data Exchange (NAWDEX) plays in supporting the water-data coordination program focused in the Geological Survey's Office of Water Data Coordination (OWDC). In order to describe this supportive role to you, I want to go back to the early stages of the establishment of OWDC and review highlights of the water-data coordination program as it has developed over the past 14 years. I hope that this brief historical sketch will help you to appreciate the important part that you as members and users of NAWDEX contribute to this coordination activity.

In the United States, many Federal agencies and literally hundreds of State and local agencies, universities, and private companies are involved in acquiring and disseminating water data. In 1964, in an effort to meet the increasing demands for water data in an efficient and economical manner, the Office of Management and Budget issued Circular A-67, which prescribed guidelines for coordinating water-data acquisition activities by Federal agencies involved directly or indirectly in acquiring and using water data. The scope of Circular A-67 includes processing, storing, and disseminating data, as well as collecting quantitative and qualitative data for the Nation's streams, lakes, estuaries, reservoirs, and ground waters. Lead-agency responsibility for implementing Circular A-67 was assigned to the Department of the Interior's Geological Survey, the agency that acquires the majority of water data at Federal level. To carry out the A-67 mission, the Survey established the Office of Water Data Coordination. The major functions of this office are to carry out the lead-agency responsibility for (1) designing a national network for acquiring water data, (2) coordinating national network and specialized water-data acquisition activities, (3) maintaining a central catalog of information on all water-data acquisition activities, and (4) developing a national plan to acquire needed water data.

To provide advice and counsel in implementing Circular A-67, the Secretary of the Interior established two committees in 1965: The Interagency Advisory Committee on Water Data and the Advisory Committee on Water Data for Public Use. The Interagency Advisory Committee on Water Data, or the "Federal Committee," consists of representatives of some 30 Federal agencies and provides the interagency liaison and participation required by Circular A-67. The Advisory Committee on Water Data for Public Use, or the "non-Federal Committee," is comprised of representatives of national, State, and regional organizations, universities, professional and technical societies

[1]Chief, Office of Water Data Coordination, U.S. Geological Survey, Reston, Va.

and consulting firms. It provides a forum for input from a broad sector of the non-Federal community. I see members of both these committees in the audience here today.

In developing plans to implement the circular, the need for improvements in collecting water data and in handling and disseminating the data received early attention. The Federal Committee discussed these subjects at its fourth meeting and proposed the formulation of two interagency work groups to study the needs and make recommendations. As a result of these proposals, the Federal Interagency Water Data Handling Work Group and the Federal Interagency Work Group on Designation of Standards for Water Data Acquisition were impaneled in 1970.

Following two years of interagency efforts (1970-72), these work groups produced significant recommendations for acquiring and handling water data. Recommendations from the work group on designation of standards resulted in the compilation of the preliminary report, "Recommended Methods for Water Data Acquisition," the forerunner of the new "National Handbook of Recommended Methods for Water-Data Acquisition." Ivan Johnson, in his presentation later today, will cover the details of the recommended-methods activity and its relation to NAWDEX.

The data handling work group recommended establishing NAWDEX, which would develop a fully coordinated water-data handling system. In 1976, as a result of this recommendation, NAWDEX was formally established as an activity of the Geological Survey.

In order to meet the specific requirement under Circular A-67 to "maintain a central catalog of information on national network and specialized water-data," the "Catalog of Information on Water Data" was established by OWDC in 1966. The catalog currently consists of four sections: (1) streamflow and stage, (2) quality of water, (3) ground water, and (4) areal investigations and miscellaneous activities. Information in the catalog is supplied by more than 300 Federal, State, and local agencies and universities in the United States. In addition, the Canada Department of Fisheries and the Environment provides information for station activities along the international boundary.

Initially, indexes to the individual catalog sections were published on a nationwide basis. Beginning with the 1972 edition, two of the indexes, surface water and water quality, were combined and presented in 21 regional volumes, one for each of the major water-resources regions in the United States. A special index to the catalog, the "Index to Stations in Coastal Areas," was published in 1977, and another special index listing activities in coal-resource areas is currently being assembled.

The basic concept behind the catalog is to obtain information about ongoing and planned data-acquisition activities and to organize this information in such a way that data collectors can coordinate their programs and data users can determine what activities are underway that could provide data to meet their needs. The catalog is essentially a file of information about water-data activities and is not a compilation of the collected water data.

If this description of the "Catalog of Information on Water Data" sounds familiar to NAWDEX members, it is because the catalog file served as the basis for creation, in 1976, of the Master Water Data Index (MWDI). Initially, information about data acquired at some 50,000 sites was obtained from the OWDC files to create the MWDI. Since then, the number of sites identified in the MWDI has grown to nearly 200,000, with the addition of large blocks of data describing historical and short-term station activities. A large part of this increase can be attributed to the direct interface with the U.S. Environmental Protection Agency's STORET (Water Quality Data Storage and Retrieval System) system and the Geological Survey's WATSTORE (National Water Data Storage and Retrieval System) system. Thus, the NAWDEX operation, through its expanding membership capabilities and its direct interface with automated data systems has led to cataloging of information about data acquired at large numbers of data sites that were not included in the past cataloging efforts.

The cataloging effort is now carried on in cooperation with the NAWDEX activity. It is an important first step in carrying out most of the other responsibilities assigned to OWDC. One of these principal responsibilities is to design the National Water Data Network. The design concept for the National Network, initially developed by OWDC in 1966, includes not only data acquired through station-type investigations but also data obtained through areal investigations and synoptic studies of water systems. Data on streams, ground water, water quality, and water use, and from areal studies will be interrelated to provide understanding, accounting, and surveillance of hydrologic systems.

The network encompasses three levels of information (fig. 1). Level 1 is a base level of information for broad national and regional planning and assessment. It allows for the development of unanticipated needs and provides a foundation for more detailed and precise activities. Information at this level should be sufficient for a rough estimate of the water-resources quantity and quality in any given place at any given time. Level II includes data for water-resources planning needs within a subregion, which is usually a trunk stream basin. Three interrelated elements carry through levels I and II, namely accounting, surveillance, and areal synthesis. Level III consists of data for water-resources operation and management at the local level.

To meet the objective for accounting at level I, the United States was divided into about 350 hydrologic units designated as accounting units. The accounting units nest within the major water-resources planning subregions and regions of the United States. For each accounting unit, information about available data and ongoing data activities can be

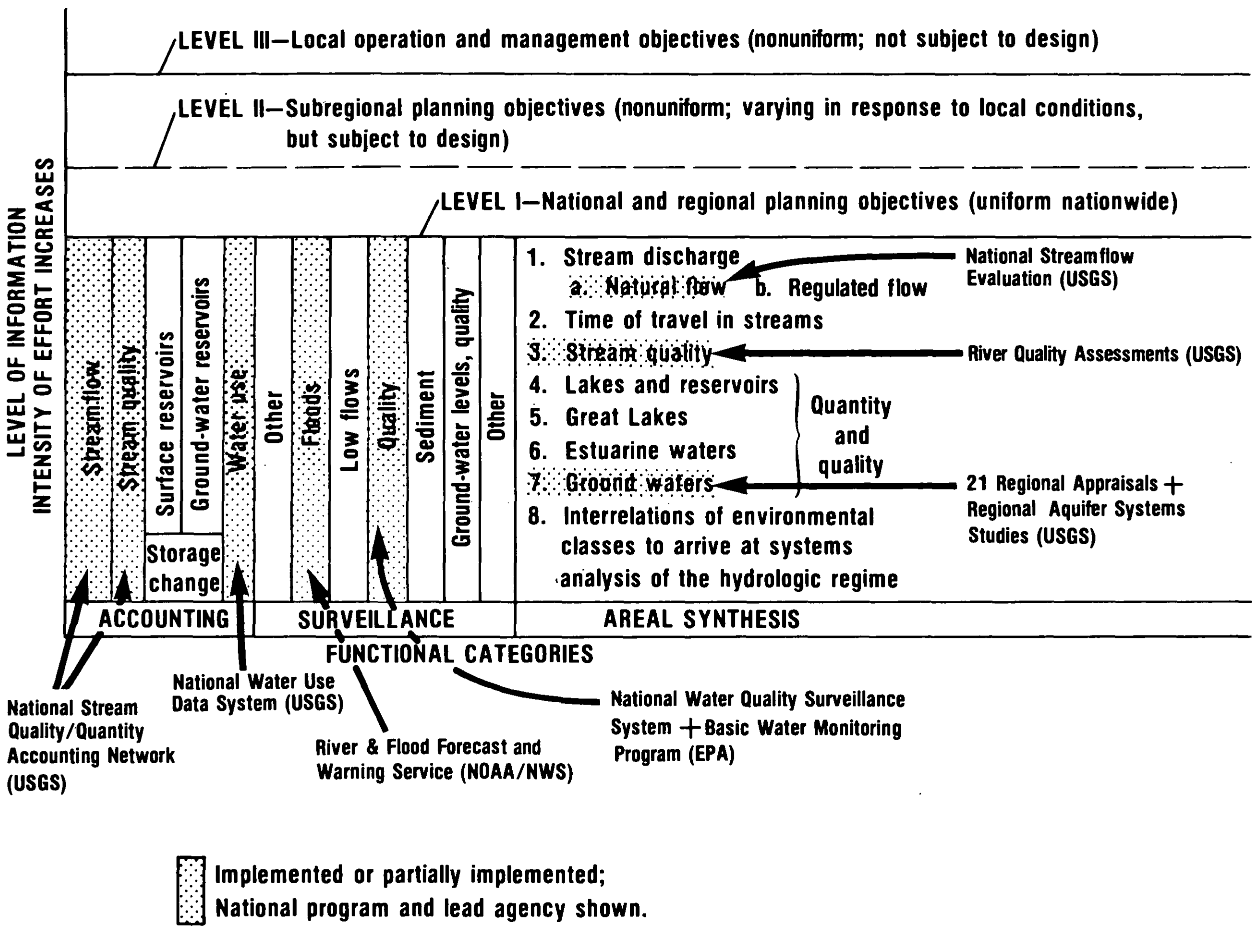

Figure 1.--Conceptual Model of the National Water Data Network.

retrieved from the MWDI, and stations can then be selected which best represent hydrologic conditions within that unit. Also through this process, data deficiencies can be identified, and new activities can be planned to remedy them. NAWDEX assists in network design by providing the basic information on available data so that meaningful testing of design objectives can be made, areas of insufficient coverage can be identified, and gaps in the data base can be filled.

To date, the main focus of the National Water Data Network design effort has been on two the level I objectives, namely streamflow and stream quality accounting. These objectives are being met by the Geological Survey's National Stream Quality/Quantity Accounting Network (NASQAN), which when fully implemented in 1979, will consist of approximately 525 stations with at least one station at the downstream end of each of the 350 accounting units. With the development of the Survey's National Water Use Data System in 1978, the water-use component of the level I accounting element is currently being implemented. The Geological Survey currently is also in the process of preparing a series of summary appraisals of the ground-water resources of each of the 21 water resources regions. Together with the studies of major regional aquifer systems that are just underway, we expect that this series of regional appraisals will constitute the ground-water component of the network's level I areal synthesis element.

Another closely related OWDC responsibility which requires the support of NAWDEX and the MWDI is the development of the regional and Federal plans for water-data acquisition by Federal agencies. In its coordination role, OWDC works with representatives of some 30 Federal agencies to determine their water-data needs. In 1971, and every year since, concerned Federal agencies have been requested to describe their ongoing data activities and their plans for acquiring water data through the budget year. The agencies are also asked to describe any unmet data needs they now have or can foresee. To assist the agencies in planning their activities and determining their data needs, regional station listings are provided to be used for updating and as a base for indicating areas of new or needed activities. This information is then assembled into a "Regional Plan for Federal Water-Data Acquisition" for each of the 21 regions. The 21 regional plans are then used to prepare the "Federal Plan for the Acquisition of Water Data." These reports set forth the ongoing and planned activities and the unmet needs of participating Federal agencies for the coming fiscal year.

As you can see, NAWDEX is an extremely important part of the total activity aimed at improving the planning and coordination of water-data programs in the United States, and it improves accessibility to water data regardless of what organization, Federal or non-Federal, collected the data or where the data or stored. As NAWDEX continues to improve and expand the bank of water-data information and its capability to respond to queries about data holdings, its utility in assisting OWDC to carry out the planning and coordinating function will increase, as will its utility in assisting data users to locate and obtain data needed to meet their needs. The continued development of a viable and responsive NAWDEX is essential if the fully coordinated and responsive system envisioned in Circular A-67 is to be realized.

I look forward to a successful meeting here in Denver, and trust that working together we will be able to develop new approaches to improve the accessibility, reliability, and compatibility of water data in the United States.

OBJECTIVES OF THE FIRST MEMBERSHIP CONFERENCE OF THE NATIONAL WATER DATA EXCHANGE (NAWDEX)

By Melvin D. Edwards[1]

Good morning, ladies and gentlemen. I would like to offer my own personal welcome to you this morning, as the Program Manager of NAWDEX. I'd also like to thank Joe Cragwall, Hal Langford, and Sol Lang for taking time form their busy schedules to be with us this morning to help us initiate this very first NAWDEX membership conference.

I have talked to many of you on the telephone, and you were just voices over the wire to me. I am very happy to have met many of you, and I hope that I will get an opportunity to meet all of you before the conference is over.

The conference chairman always introduces everyone else, but he never gets introduced himself. I would like to point out that our conference chairman, Sol Lang, is the Deputy Assistant Chief Hydrologist for Scientific Publications and Data Management for the Water Resources Division and currently is sitting in as Acting Assistant Chief. Sol has been active in NAWDEX from the very beginning. He was the Executive Secretary of the Interagency Water Data Handling Work Group, and it was mainly through Sol's efforts, during the period 1971 to mid-1975, that NAWDEX stayed alive. So, a vote of appreciation is due Sol for his efforts on behalf of all of us.

This first membership conference is a significant milestone in our development and implementation of NAWDEX. It is the first opportunity for us to become personally acquainted and spend a brief time together focusing our full attention on the mission and goals of our program. An annual conference is a defined part of our program of operation and I believe that these sessions are vital if we are to advance the program in a manner that will best fit both our needs and those of the user community.

NAWDEX is directed toward the goals of developing a nationwide confederation of organizations that work together to facilitate the transfer of data between the collector and user communities, to provide a comprehensive and accurate accounting of existing water data, to identify sources of water-related data, and to improve the technology of data handling and transfer. The objectives of our first conference, therefore, are directed toward achieving these goals.

Our objectives of the first day are for you to meet each other and become familiar with many of the systems and services available within our

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[1]Program Manager, National Water Data Exchange Program Office, U.S. Geological Survey, Reston, Va.

membership. Papers are being presented on national-level programs that are supported by NAWDEX, provide support to NAWDEX, or will have a future impact on the NAWDEX program. Presentations also will be given by various members relevant to their data needs, data systems, services, and other activities pertinent to the program, in order to better acquaint all of us with the facilities and resources available throughout our membership. Several of these presentations are reinforced by exhibits, literature, and displays to provide additional information and demonstrate their capabilities. I hope that each of you will take full advantage of the exhibit area and acquaint yourselves with these systems. Beyond the presentations, I hope that a lot of personal interchange will take place. Each of us needs to help close our communication gaps. Our conference provides a forum for this. We have representatives from both the collector and user communities here today. It is important to the success of NAWDEX that you talk to each other. The conference is an excellent opportunity to express your needs, concerns, and ideas.

The second day is directed toward discussing our objectives for the forthcoming year and to working together at assessing the status of the program, defining needs of the program, improving our operations, and correcting any deficiencies in the development and advancement of the program. Ad hoc panel sessions are being conducted to address four specific elements of the program: Program Administration, Management, and Coordination; Water Data Indexing and Technical Systems Development; Request, Response, and Service Activities; and Recommended Standards for the Handling and Exchange of Water Data. Where possible, each of you were extended an invitation to participate in the panel sessions based upon your expressed area of interest. For those of you who did not receive an advance invitation, I hope that you will select a panel and actively participate in the proceedings tomorrow. Guidelines for each of the panels have been provided to you to help in your selection. The panel sessions provide an opportunity for each of you to apply your expertise and personal input to the program. The results of these panels will be invaluable as we advance NAWDEX. I am confident they will lead to significant improvements in our planning and operational processes.

Our third day has been set aside for us to discuss the results of our conference and to discuss other matters which you feel will be of mutual interest to the participants.

A summary of the proceedings will be published as soon as possible and distributed to participants, all NAWDEX members, and other interested parties. This document should be a valuable aid in helping you to better fit the NAWDEX program into your own planning and operational processes.

I sincerely hope that each of you will leave here on Thursday with a feeling of accomplishment; a firm sense of being a part of NAWDEX; a better comprehension of our mission, goals and accomplishments; and enthusiasm for the continued advancement of our program.

STATUS OF THE NATIONAL WATER
DATA EXCHANGE (NAWDEX)--MAY 1978

By Melvin D. Edwards[1/]

I am pleased to announce that we have continued to make good progress in the advancement of NAWDEX since the last status report of our activities as of September 1977. Membership has continued to expand. We currently have the membership support of 112 organizations. This is an increase of 31 percent since September. I invite all of you here today who are not yet members of NAWDEX to become participants in our program. Draft copies of the Memorandum of Understanding required to be signed for membership and application forms are available in the exhibit area. Membership is voluntary and there are no dues or fees associated with becoming a member. We need your support to help us to improve our communication throughout the water-data community, develop a viable index of available data, and improve our data exchange processes.

We have continued in our efforts to increase the public awareness of NAWDEX. The NAWDEX Newsletter now has over 500 subscribers and the third issue was distributed in November 1977. A NAWDEX brochure describing the program and our services has just been published and is being introduced here today. To date, several hundred information packets have been mailed in response to inquiries about NAWDEX. NAWDEX personnel have also participated in a variety of technical and scientific meetings this fiscal year. These include: The Fourth Joint Conference on Sensing of Environmental Pollutants sponsored by the American Chemical Society in New Orleans, La.; the Geoscience Information Retrieval Update Symposium sponsored by the Geological Society of America in Seattle, Wash.; the Third Annual STORET Users Meeting conducted by the U.S. Environmental Protection Agency in Bethany, W. Va.; the 50th Anniversary Conference and Exhibition of the Water Pollution Control Federation in Philadelphia, Pa.; and Water Resources Conferences conducted by the Geological Survey in the states of California, Arizona, New Jersey, and Georgia.

The NAWDEX service activity is continuing to expand. Nearly 31,000 request/response transactions were conducted in the first two quarters of Fiscal Year 1978. The newly affiliated membership services of WRSIC, (Water Resources Scientific Information Center), EDS (Environmental Data Service), STORET (Storage and Retrieval system of the Environmental Protection Agency), and WATDOC (Water Resources Document Reference Centre, Canada Department of Fisheries and the Environment) were announced in our last Newsletter and NAWDEX referrals to these services are expected to increase this year. Local Assistance Center personnel were briefed on these new services and in the use of new software facilities to support inhouse

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[1/]Program Manager, National Water Data Exchange Program Office, U.S. Geological Survey, Reston, Va.

NAWDEX services at two training sessions conducted by the NAWDEX Program Office in Denver, Colo., and Reston, Va., in late November and early December.

Our information resources also continue to expand. Over 420 organizations are currently registered in the Water Data Sources Directory and nearly 200,000 sites have been indexed in the Master Water Data Index. This includes the indexing of the Daily Values File and Peak Flow File of the Geological Survey's WATSTORE system which was completed in April. The first indexing update of the water-quality data stored in the Environmental Protection Agency's STORET system has already begun. This task will include water-quality data concurrently stored in the STORET and WATSTORE systems during calendar year 1977 and is scheduled for completion by July 31, 1978. Indexing is also underway on the ground-water quality data contained in the archived file of STORET. These are predominately data contributed to STORET from the WATSTORE system and are expected to add an additional 100,000 ground-water sites to the Master Water Data Index by the end of Fiscal Year 1978.

The information contained in the Water Data Sources Directory is still incomplete at this time. Work on the Directory has been given low priority during the past year due to the rapid-growth demands of the Master Water Data Index. High emphasis will be given to the Directory during late Fiscal Year 1978 and early Fiscal Year 1979, however, to bring this important data base up to date. In the interim, system design and software development is underway to provide the facility for storing information on water-related data in the Directory. This work is scheduled for completion in September of 1978 and the new capability for water-related data will be implemented in early Fiscal Year 1979. There has been a high demand for this type of information and this addition will greatly expand our reporting capability to our users.

The gathering of information by manual encoding procedures for the Master Water Data Index has been rescheduled in order to better coordinate this process with the data gathering procedures of the Office of Water Data Coordination (OWDC) in the development of its Catalog of Information on Water Data. This was done, specifically, to eliminate duplication of effort. Instructions for the encoding of data have nearly been completed by OWDC. These instructions will be distributed to the membership in the near future and data gathering can be expanded at that time. Work is under way in requesting approval from the Office of Management and Budget for interagency use of NAWDEX-designed encoding procedures for both data bases. These procedures will be implemented throughout the membership upon receipt of this approval. Procedures for updating the MWDI were implemented within the Geological Survey in September 1977 for testing and validation purposes. Their use, thus far, has proven them to be a viable system. Currently, a computerized system for the interim translation of data collected in the OWDC format into NAWDEX compatible formats for entry into the MWDI has been implemented and is in use for non-USGS data indexing. Also, the edit/update software system for the entry of data into the MWDI has been extensively tested and is fully operational.

Work was completed in April on the initial interface with the digitized files of Hydrologic Unit Code maps developed and implemented by the Office of Water Data Coordination. Using these files, the eight-digit hydrologic unit codes based upon the 21 major hydrologic regions defined by the U.S. Water Resources Council have been assigned to all sites in the MWDI that are identified by latitude and longitude. We are now integrating these digitized files into the NAWDEX update procedures for the MWDI. For the first time, we now have a practical method for the automated assignment of a standardized hydrologic identifier to all sites identified by latitude and longitude regardless of the source of input. This is an important contribution to our data-response capabilities and the water-data community.

Generalized-retrieval software for the MWDI is now fully operational. This system provides a high degree of flexibility for individual users to select data from the MWDI based upon their specified criteria and to format the output to fit their individual needs. This system is designed to provide a reporting mechanism for NAWDEX members and users to produce meaningful inventory and management-type reports. The system consists of a retrieval module, a report generator, and a site-location plot interface.

A variety of systems documentation and user manuals have been developed and printed. This documentation will be reviewed during the conference and its applicability to general membership use appraised.

A significant funding increase of $400,000 was allowed the NAWDEX Program Office in Fiscal Year 1978, bringing our operating budget this year to $676,000. An additional increase of $500,000 has been requested for Fiscal Year 1979, bringing our projected budget to 1.2 million dollars. The allocation of this increase by Congress looks very promising at this time. This level of funding gives NAWDEX a healthy financial outlook and assures the continued momentum required to make the program a success.

The staff of the Program Office currently consists of nine full-time and two part-time employees. The work of the staff is supplemented by contractual support in the areas of systems design, data-base, and software development. We plan to acquire both additional personnel and contractual support during Fiscal Year 1979 to further assure the continuing development of a viable, responsive program.

We have accomplished much in the brief timespan of NAWDEX implementation. We still have a lot to accomplish. Our objectives for next year will be discussed tomorrow. The support of you, the membership, has been excellent. I am sure that I can rely upon your continued support. Together, we can make NAWDEX truly successful.

THE COLORADO WATER DATA BANK

By Walter I. Knudsen, Jr., and Dr. Jeris A. Danielson[1/]

Over the past several years, the Division of Water Resources has received numerous inquiries concerning the Colorado Water Data Bank. Generally speaking, the inquirer wants to know what it is and how it is used. At the conclusion of this presentation it is my hope that you will know: 1) Why a Colorado Water Data Bank; 2) What is the Colorado Water Data Bank; and 3) How is the Colorado Water Data Bank being used. During the presentation the words "Data Bank" should be taken to mean the Colorado Water Data Bank, and the term "Division" to mean the Division of Water Resources, or as many would prefer, "The State Engineer's Office."

Why a Colorado Water Data Bank? That could perhaps be briefly explained by saying that the demand for accurate and complete water resource data by many sectors of our society starting in the 1960's quickly showed that the traditional methods of accumulating, storing, interpreting and utilizing water resource data were not going to work very well in servicing these demands. One might say that, legislatively, these demands coalesced into the Water Rights Determination and Administration Act of 1969. Perhaps the two most important features of this act from the point of view of why a data bank are: 1) The legislated policy of the State to integrate the appropriation, use and administration of underground water tributary to a stream with the use of surface water in such a way so as to maximize the beneficial use of all waters of the State; and 2) The State Engineer had to develop and publish a complete listing of all decreed water rights existing in the State of Colorado.

Many persons both within the legislature and elsewhere, who were very concerned about, and with, the water resources of Colorado recognized the fact that this legislation was placing an additional responsibility upon the conditions that existed at that time. These and other concerns arising out of the 1969 act and subsequent legislation affecting both the surface and ground water of the State, and the use of the land of the State, caused the State Engineer and the key members of his staff to begin thinking, in more concrete terms, about a Colorado Water Data Bank.

During the summer of 1971 a pilot study was conducted in order to gather data relating to the computerization of our diversion and other technical records. This study culminated in a feasibility report completed in December of the year. This report was presented to the 1972 Legislature and was the basis for the funding of the Colorado Water Data Bank.

What is the Colorado Water Data Bank? It is many things to many people. Colorado State University (CSU) would perhaps take the point of view that the data bank is a very interesting and necessary applied research

[1/] Chief, Computer Services, and Deputy State Engineer, respectively, Colorado Division of Water Resources, Denver, Colo.

project benefiting two areas: 1) Water resource data collection and reporting systems with some very obvious beneficial uses in the general area of water resources research, particularly as it applies to Colorado; 2) Water resource data organization, storage and retrieval using the computer and a concept loosely referred to as a data base. The latter involves computer programs usually referred to as data base management systems.

To non-Division users of our data bank it is either a wonderful and needed means for providing water resource information to the user, or it is a frustrating experience with something that should be (and is to a limited extent) providing this needed information to the user, better than we use to for the most part, but not as sophisticatedly as they--or the Division as a matter of fact--would like. In other words, to the non-Division user, the data bank is basically an information system oriented to the retrieval of water resource data.

The Water Division Engineers, their assistants and the water commissioners view it as a lot of hard, and sometimes frustrating, work. But this project, including the water rights tabulation, would have been an impossible task if it had not been for the Water Division Engineers and their water commissioners.

The data bank is all of that, and more, but is not an end unto itself. One purpose is to provide more accurate and meaningful raw water resource data to all those sectors of our society who need it. During the pilot study and the implementation of the data bank project, it became painfully clear that a number of terms used in water administration differed in their meaning throughout the State and indeed, even within a Water Division. The terms direct, exchange, supplemental, miners inch, priority--and others--have had variations in their meaning and intent throughout the State. It can be shown where historic water resource records have not been uniform in their method of recording and the meaning attached to the recorded data. There have been times when the purpose of the data bank has been described as the computerization of the Division's technical data. This is partially true. But, the computerization of data without the understanding of the data is an exercise in futility and a waste of money.

The development of the data bank has been impacted by at least three different groups. They are the Water Project (Data Bank) personnel at CSU, Division personnel in the seven Water Division offices, and Division personnel in the Denver Office. The project work effort has been divided between CSU and the Division. CSU is responsible for the design and implementation of computer programs and systems, and the Division is responsible for the design and implementation of the manual data entry and reporting systems, and the overall management of the project.

The Colorado Water Data Bank contains Colorado water resource data collected by the Division and other governmental agencies. The several categories of the water resource data collected and entered (or to be entered) into the Water Data Bank are described below and diagrammatically shown in figure 1.

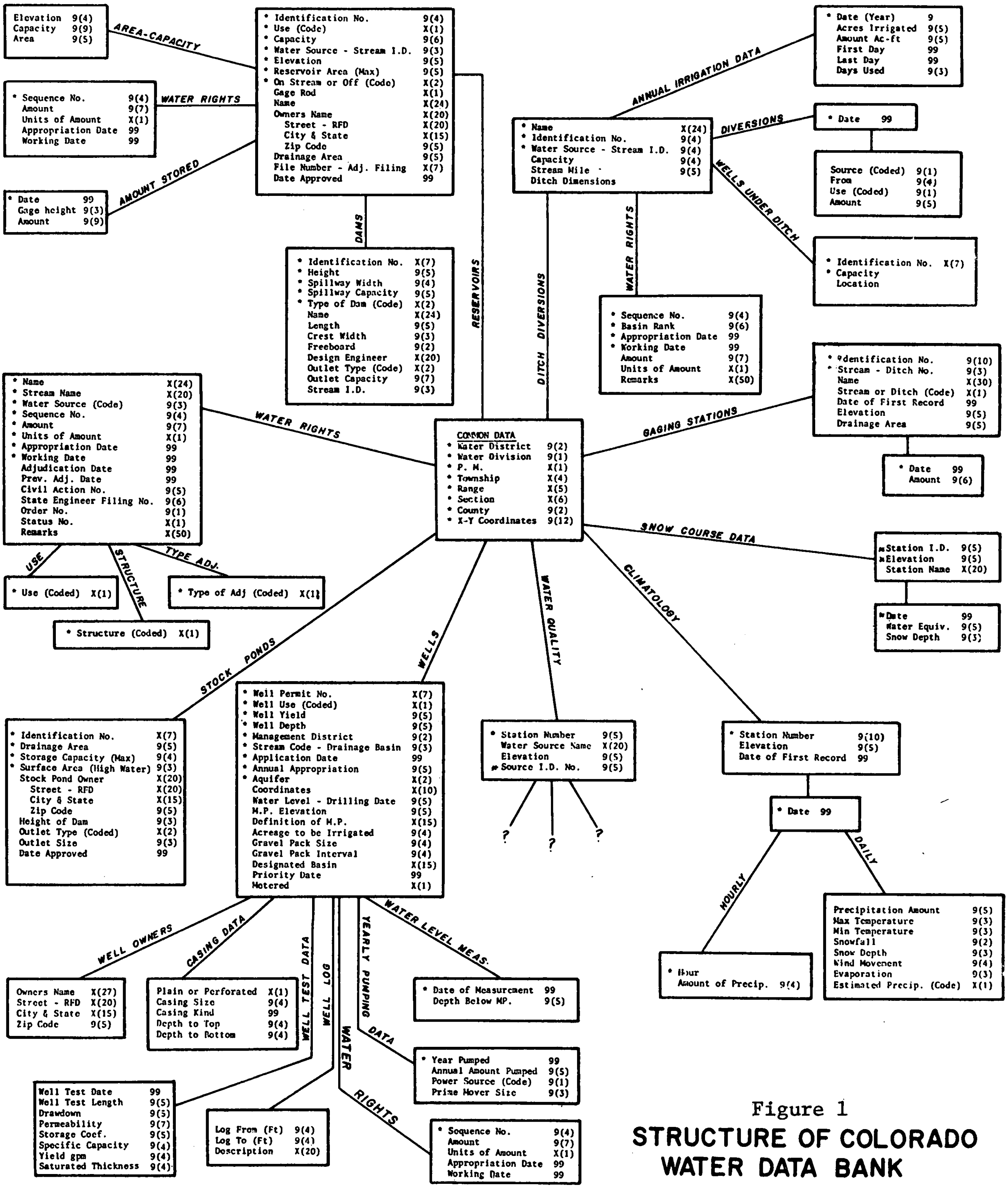

Figure 1
STRUCTURE OF COLORADO WATER DATA BANK

November 1, 1972

REVISION I: NOVEMBER 21, 1972

Water Rights: The Colorado judicial system is empowered to adjudicate the water rights in the State of Colorado. The State Engineer's Office receives copies of the court decrees and abstracts them for inclusion in a tabulation of water rights for the State of Colorado. The data included in this tabulation are the name of the structure, it's location, decreed amount, decretal dates, and other administrative information.

Water Diversions: The State Engineer's Office field personnel administer the waters of the State according to State statute and court decrees. Records are kept on the amount of water diverted from the rivers, streams or ground-water of the State into the various ditches, canals, reservoirs or other types of diversion structures. The data include the source of water, its use, the diverted amount measured in cubic feet per second of time (ft^3/s) or acre feet (acre-ft) and the date of the measurement.

Reservoir Storage: Periodic readings are taken of the gage height and corresponding stored volume of many reservoirs in the State. The frequency of such readings is dependent upon the accessibility of the reservoir and the need to make such measurements. Inflow and/or outflow records are kept on those reservoirs critically involved in water administration.

Wells: The State Engineer's Office maintains a computerized record of all registered wells in the State of Colorado in addition to the permit/registration documents. This record contains the name and address of the registrant, location of the well, it's initial yield and water level, depth and other administrative data. The annual diverted amount is kept in a few selected cases. Well log data will eventually be incorporated into the computerized record.

Stream Gaging Station: The State Engineer's Office in cooperation with the U.S. Geological Survey (USGS) maintains stream-gaging stations on numerous rivers and streams of the State of Colorado. The flow data are recorded as an average daily flow. Also incorporated into the record are other descriptive data such as location, drainage area and other geographical parameters.

Climatological Data: Climatological data consisting of daily maximum/minimum temperatures, precipitation and other climatological parameters have been acquired for each station in Colorado where such data are or have been recorded.

Livestock Water Tanks: The State Engineer permits and registers structures known as "Livestock Water Tanks." These structures are used primarily for the watering of livestock. The data consist of the registrant's name and address, location of structure, capacity, and other administrative data.

Dams: The State Engineer maintains a roster of dams located in the State of Colorado. The data consist of the dam name, location, physical characteristics, drainage area, capacity of reservoir, owner/engineer information, and other pertinent engineering and administrative data.

Snow Course Data: The State Engineer, in cooperation with the U.S. Soil Conservation Service, maintains snow courses in the mountains of Colorado for the purpose of estimating the water runoff volumes that will become part of the normal streamflow. The data include the station location, date of measurement, snow depth, and water equivalent.

Water Quality Data: It is anticipated that water quality data collected by the Colorado Department of Health, the USGS, and other governmental agencies will eventually be incorporated into the Colorado Water Data Bank.

Figure 2, WATER DATA BANK INTERRELATIONSHIPS, shows that data bases will interrelate one with another. For example, we want to be able to cross reference water rights as they related to wells, diversions, or reservoirs. At the same time, both wells and reservoirs will be cross referenced to water diversions. Why? It is becoming quite common to have a well decreed as an alternate point to a ditch diversion, and diversions will go to storage at certain times of the year. A ditch headgate can and does, in many instances, have more than one priority diverted through it.

A not-so-hypothetical case of the need for such interrelationships is a water study along a specified reach of a stream. Or, a user may want to know what the average streamflow has been at a certain point, what the historic diversions have been for a particular structure and what senior rights are downstream (upstream senior rights have already taken their water). The data base interrelationships will be such that this information will be available with a minimum of effort. There are at least two ways that the desired information may be extracted from a data bank to meet these needs. First, the stream (or set of streams) is specified, and all diversions, reservoir storage information, streamflow data and water rights are extracted for analysis. Or, instead of by stream, the data may be extracted by legal location. The analysis of the data is external to the data bank.

Several data bases have been defined and established on the CSU computer using MRI's System 2000 Data Base Management System. They are Water Diversions and Reservoir Storage, Water Rights, Gaging Stations, Climatology, and Dam Structures. As of now, only two of the proposed data bases have been integrated. They are water diversions and reservoir storage. Figure 3 shows the integrated data base. Water rights are shown

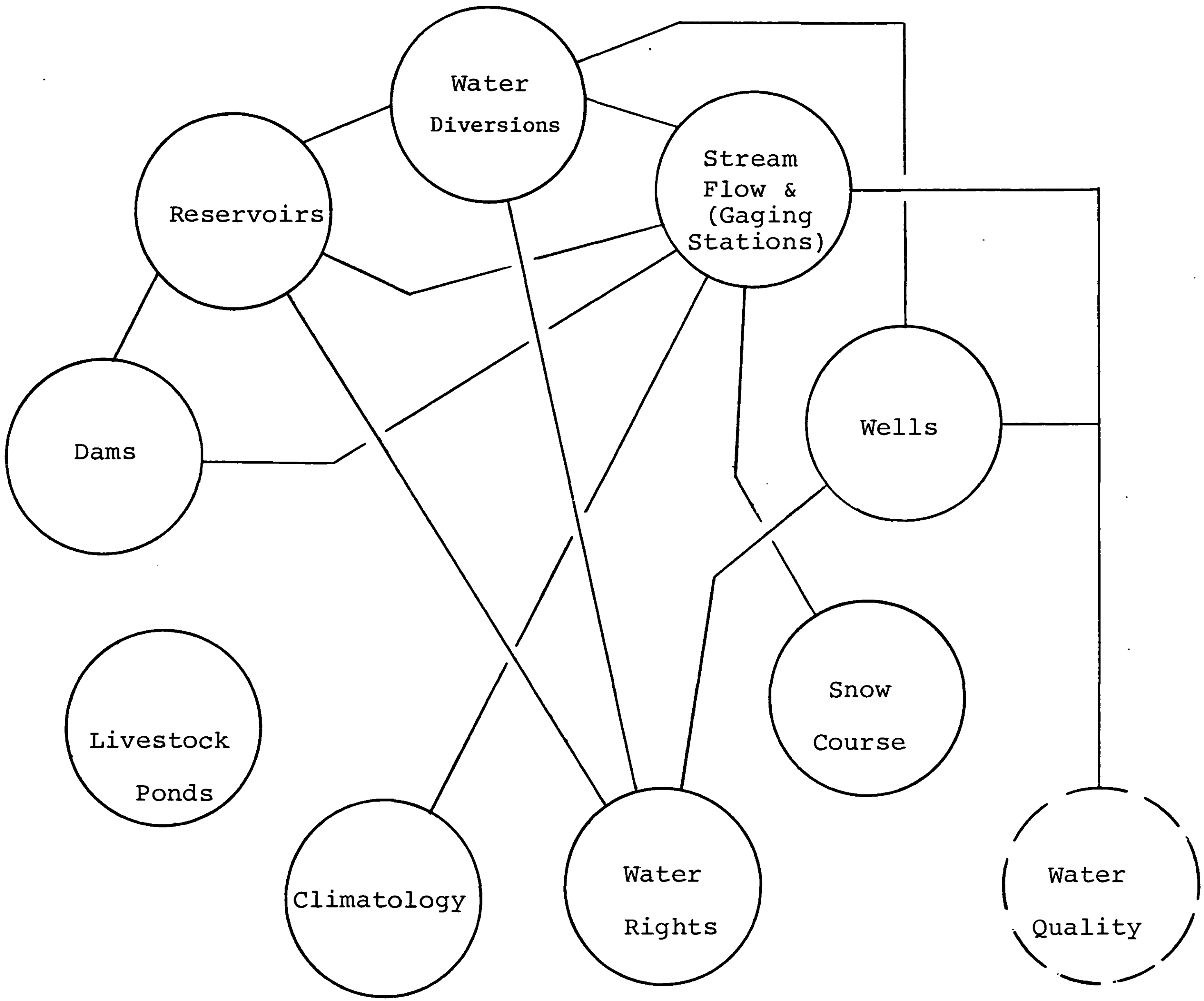

Figure 2.--Water Data Bank Interrelationships.

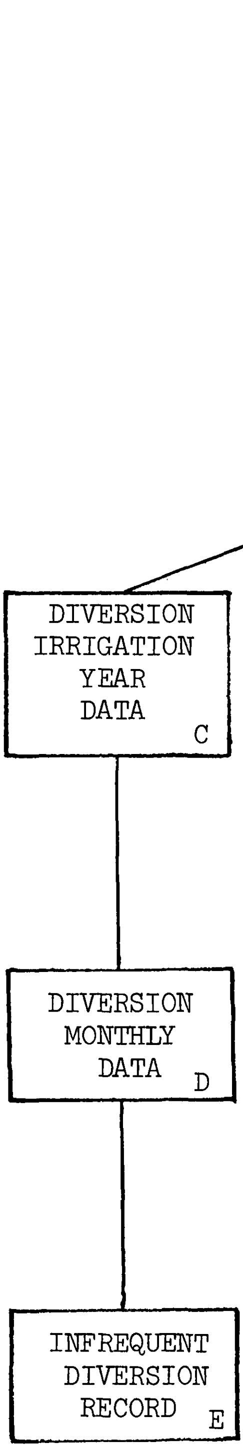

Figure 3.—Colorado Water Data Bank.

to the right. They exist as a separate data base that will probably be integrated with the water diversion and reservoir data base as shown in figure 3.

For two or more years a mark sensing form was utilized to enter ditch diversion and reservoir storage data. This form was discontinued due to coding and machine problems and a change was made to using key-punched cards as the prime medium for the entry of all data.

Data collection activities start at the point where data is captured on a coding form. In the case of water rights it is the abstracting of a decree and coding that information on an adjudication card. For diversion data, the water commissioners measure the flow of water through the headgate and record the information on a coding form. The data entry form most commonly used by the field personnel for recording water diversion can record a half-month's worth of data for a maximum of 29 structures. The Division's use of this form has indicated at least two major advantages for it: (1) The form can be the water commissioner's actual record; and (2) data can be keypunched directly from this form. Keypunching may be done in the local area, the cards listed, and the card listing reviewed by Water Division personnel prior to shipping the cards to Denver. The Denver Office also keypunches much of this data.

The data update process reads the data into the computer and updates the data bases with new information or changes to existing information. When the diversion data is read by the computer it is edited at two levels. The first level of editing edits the card to see if certain fields have data and if these fields have been correctly keypunched. The second level of editing occurs at the time of data base update. At this time the data are checked against the data base to ensure that a structure exists for the data, and to discover duplicate entries or other errors. We have experienced approximately 1 percent total error and most of these have been due to misunderstandings of the coding system.

Data retrieval may be divided into two areas. The first concerns itself with verifying that the existing information in the computer is correct. The second concerns itself with extracting data to give to someone. The Division receives numerous requests for copies of the water resource data it collects and maintains.

In summary, the Field Divisions collect the data, code it onto forms, and either they or the Denver Office arrange to have the data keypunched. The Denver Office transmits the data to the CSU computer through the RJE Terminal in the Denver Office and the data bases are updated. The data retrieval process originates in the Denver Office via the RJE Terminal and the reports are printed on the terminal printer.

The data may be retrieved and reported in a number of formats. Figures 4 and 5 show a sample water rights tabulation reports for pages A and B. Figures 6 through 12 show a series of reports for water diversions for one structure. Figures 6 through 10 are the flows for specific categories of water (as described in the following paragraph), and figure 11 is the total flow for all water for all uses through that structure. Figure 12 is a sample of an infrequent data report (diversion data for a "period" of time vs. daily values), figure 13 a water diversion summary report, and figure 14 a water use summary report.

A brief comment concerning "categories" of water as used in our diversion records is in order at this time. Water is identified through its source (river, reservoir, ground water, transbasin and non-stream), its use (ten of them), "type" (basically a piece of information entered when further administrative identification is needed as in the case of exchange water, and "from" (another administrative identifier available when needed, as for example, to identify what reservoir the water came from). A unique combination of these four codes is a water category. Figure 15 identifies these codes.

The Division has a number of future projects in mind. First and foremost is the integration of the water rights data base with the diversion records data base. On the surface this seems like a simple operation. However, it will involve a lot of painstaking detailed work in checking and rechecking the relationship between particular water rights actions and diversion structures.

Another project will involve the integration of stream gaging, climatological, and dam data with the diversion records and water rights. By far the largest and most complex project will be the integration of the well and livestock water tank files with the diversion records and water rights. This project will take some time to accomplish since there are two major impacts: The physical size of these data files and the finances needed to integrate and operate them.

Another project the Division has in mind is to provide direct access to the data bank from the Water Division Office. The major problems to be resolved are communication links, operating criteria, fiscal controls, and financing.

It was stated earlier that the data bank was not an end unto itself. The questions to be answered here are how does the Division use the data bank and how do others use the data bank. One of the purposes of the Colorado Water Data Bank is to computerize the technical records of the Division. To that end, the current water diversion records are being coded for entry into the data bank by the various Water Divisions. They also verify the data before signing the official diversion report. Personnel in the Denver Office are entering and verifying the historic diversion data and current well file information. The water rights data is being continually reviewed by both

Water Rights Tabulation Report - Page A

DIVISION 1

STREAM ALPHA LISTING - WATER DISTRICT NO 8

NAME OF STRUCTURE	TYP (1)	NAME OF SOURCE	WD	P M	TWN	RNG	SEC	160 40 10	USE (2)	AMOUNT	TYP ADJ (3)	ADJ DATE	PREV ADJ DATE	APPRO DATE	BASIN RANK
MARSHALL DITCH	D	EAST CHERRY CREEK	08	S	10-S	65-W	04	NENE	I		S	05/23/1904	03/03/1890	04/30/1903	1503
MILLER DITCH	D	EAST CHERRY CREEK	08	S	10-S	65-W	04	SESE	I		S	05/23/1904	03/03/1890	04/30/1903	1503
SCHREIBER DITCH	D	EAST CHERRY CREEK	08	S	9-S	65-W	21	NWNWSE	I	.7500CFS	S	06/16/1930	05/23/1904	06/01/1873	1539
BEARDSLEY E CC DIVERSION	O	EAST CHERRY CREEK	08	S	10-S	65-W	28	SWSENW	I	1.5000CFS	S,C	12/31/1974	12/31/1973	06/10/1971	9783
BEARDSLEY E CC DIVERSION	O	EAST CHERRY CREEK	08	S	10-S	65-W	33	SWNWSE	I	1.5000CFS	S,C	12/31/1974	12/31/1973	06/10/1971	9783
EAST PLUM CREEK D	D	EAST PLUM CREEK	08	S	10-S	67-W	18	NENWNE	I	.5500CFS	O	12/10/1883		07/30/1869	243
LOWELL SUMP PUMP	P	EAST PLUM CREEK	08	S	8-S	67-W	27	SWNE	I	.4920CFS	C,TT	12/31/1883		09/01/1871	285
HIGHLINE DITCH	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	3.5200CFS	O	12/10/1883		09/01/1871	285
HIGHLINE DITCH	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	.4920CFS	O,TF	12/10/1883		09/01/1871	285
HIGHLINE DITCH	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	.0930CFS	O	12/10/1883		09/01/1871	285
HIGHLINE D 1ST ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	1.4000CFS	O	12/10/1883		06/30/1873	341
LOWELL SUMP PUMP	P	EAST PLUM CREEK	08	S	8-S	67-W	27	SWNE	I	.1960CFS	O,TT	12/10/1883		06/30/1873	341
HIGHLINE D 1ST ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	.1960CFS	O,TF	12/10/1883		06/30/1873	341
HIGHLINE D 1ST ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	.0370CFS	O,AB	12/10/1883		06/30/1873	341
HIGHLINE D 2ND ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	15.0800CFS	O	12/10/1883		06/30/1878	492
LOWELL SUMP PUMP	P	EAST PLUM CREEK	08	S	8-S	67-W	27	SWNE	I	2.1120CFS	O,TT	12/10/1883		06/30/1878	492
HIGHLINE D 2ND ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	2.1120CFS	O,TF	12/10/1883		06/30/1878	492
HIGHLINE D 2ND ENL	D	EAST PLUM CREEK	08	S	9-S	67-W	04	NENENE	I	.4010CFS	O,AB	12/10/1883		06/30/1878	492
CASTLE ROCK RESERVOIR	R	EAST PLUM CREEK	08	S	8-S	67-W	11	NESESE	D	.5000AF	O	12/10/1883		04/01/1880	554
EUREKA DITCH	D	EAST PLUM CREEK	08	S	8-S	67-W	14	SWSWSW	D	7.0000CFS	S	03/03/1890	12/10/1883	03/31/1883	719
P W OBRIAN DITCH	D	EAST PLUM CREEK	08	S	8-S	67-W	14	SWSWSW	D	5.2500CFS	S	11/28/1899	03/03/1890	08/16/1893	1159
P W OBRIAN DITCH	D	EAST PLUM CREEK	08	S	8-S	67-W	14	SWSWSW	D	2.0000CFS	S,TT	11/28/1893	03/03/1890	08/30/1893	1162
CASTLE ROCK W W D	D	EAST PLUM CREEK	08	S	8-S	67-W	11	NWSWNE	D	3.4600CFS	S	11/28/1893	03/03/1890	08/30/1893	1162
CASTLE ROCK RES ENL	R	EAST PLUM CREEK	08	S	8-S	69-W	11	NESESE	D		S	11/28/1893	03/03/1890	08/30/1893	1162
CASTLE ROCK W W D	D	EAST PLUM CREEK	08	S	8-S	67-W	11	NWSWNE	D	2.0000CFS	S,TF	11/28/1893	03/03/1890	08/30/1893	1162
EAST PLUM CREEK D ENL	D	EAST PLUM CREEK	08	S	10-S	67-W	18	NENWNE	I	3.0000CFS	S	06/16/1930	05/23/1904	04/01/1890	1565
CASTLE ROCK W W D	D	EAST PLUM CREEK	08	S	8-S	67-W	11	NWSWNE	D	1.0000CFS	S	11/28/1908	05/23/1904	09/20/1891	1568
CASTLE ROCK W W D	D	EAST PLUM CREEK	08	S	8-S	67-W	11	NWSWNE	D	1.0000CFS	S	11/28/1908	05/23/1904	09/20/1891	1568
CASTLE ROCK W W 2ND ENL	D	EAST PLUM CREEK	08	S	8-S	67-W	11	NWSWNE	D	.2000CFS	S	06/16/1930	05/23/1904	08/14/1914	2164
HILL DITCH	D	EAST PLUM CREEK	08	S	7-S	67-W	20	NESWSW	I	.7500CFS	S	06/16/1930	05/23/1904	06/01/1923	2591
SERRELL OVERNIGHT RES	R	EAST PLUM CREEK	08	S	10-S	67-W	08	NESENE	IS	3.8400AF	S	05/18/1972	06/16/1930	11/23/1954	5053
SERRELL DITCH	D	EAST PLUM CREEK	08	S	10-S	68-W	08	NWSESW	I	2.0000CFS	S	05/18/1972	06/16/1930	02/17/1955	5087
SERRELL OVERNIGHT RES	R	EAST PLUM CREEK	08	S	10-S	67-W	07	NE	I	10.7400CFS	S	05/18/1972	06/16/1930	04/01/1958	5613
E PLUM CR D 2ND ENL	D	EAST PLUM CREEK	08	S	10-S	67-W	18	NESWNW	I	7.0000CFS	S	05/18/1972	06/16/1930	08/12/1958	5673
BUTTON RES	R	EAST PLUM CREEK	08	S	10-S	67-W	08	NWNESE	IRS	4.3230AF	S	05/18/1972	06/16/1930	10/06/1961	6106
LITTLETON HEIGHTS DITCH	D	GALLUP GULCH	08	S	5-S	68-W	16	SWNWSE	I	1.0000CFS	S	06/16/1930	05/23/1904	07/20/1890	1566
GARBER CREEK DITCH NO 1	D	GARBER CREEK	08	S	8-S	68-W	17	NW	I	2.7900CFS	O	12/10/1883		06/30/1861	48
GARBER CREEK DITCH NO 2	D	GARBER CREEK	08	S	8-S	68-W	09	SENWSW	I	1.0600CFS	O	12/10/1883		08/30/1863	107
CHATHAM DITCH	D	GARBER CREEK	08	S	8-S	68-W	10	NESE	I	5.0000CFS	O	12/10/1883		12/30/1864	132
SUNNY BANK DITCH	D	GARBER CREEK	08	S	8-S	68-W	11	NWSWNW	I	1.8300CFS	O	12/10/1883		06/01/1866	179
FLINTON CAREY D	D	GARBER CREEK	08	S	8-S	68-W	10	NWSESE	I	2.1700CFS	O	12/10/1883		07/30/1869	243
FLINTON COREY D ENL	D	GARBER CREEK	08	S	8-S	68-W	10	NWSESE	I	3.0000CFS	O	12/10/1883		06/30/1871	282
GARBER CREEK D NO 1 ENL	D	GARBER CREEK	08	S	8-S	68-W	17	NW	I	1.4000CFS	O	12/10/1883		12/01/1871	294
PURDY DITCH	D	GARBER CREEK	08	S	8-S	68-W	09	SENESW	I	2.0000CFS	O	12/10/1883		05/30/1873	335
LITTLE DAISY DITCH	D	GARBER CREEK	08	S	8-S	68-W	11	NWSWSE	I	.9900CFS	O	12/10/1883		05/10/1880	559
PURDY DITCH ENL	D	GARBER CREEK	08	S	8-S	68-W	09	SENESW	I	0.0000CFS	O	12/10/1883		05/30/1881	599
AHLMAAZ GOVE DITCH	D	GOVE CREEK	08	S	10-S	68-W	02	NENESE	I	2.5200CFS	O	12/10/1883		06/01/1869	242
SNYDER DITCH	D	GOVE CREEK	08	S	9-S	68-W	36	NW	I	3.0000CFS	O	12/10/1883		11/01/1879	541
ROBINSON DITCH	D	GOVE CREEK	08	S	9-S	68-W	36	NWSWNE	I	.1000CFS	S	03/03/1890	12/10/1883	01/01/1883	733
GREENWOOD RES PASSOVER	R	GREENWOOD CREEK	08	S	5-S	68-W	02	SESESE	I	5.0000AF	S	06/16/1930	05/23/1904	06/03/1909	1935

Figure 4.--Water rights tabulation report - Page A.

WATER RIGHTS TABULATION REPORT - PAGE B

DIVISION 1 — STREAM ALPHA LISTING - WATER DISTRICT NO 8

BASIN RANK	WORK DATE	ORD	SEQ NO	STA	CTY	CIVIL ACTION NO	STRUCTURE TYPE	USE TYPE	ADJ TYPE	REMARKS
1503	19478		00290	BA	18		1	1	2	267 NO AMT DECREED
1503	19478		00289	BA	18		1	1	2	26[illegible] NO AMT DECREED
1539	19868		00312	D	18		1	1	2	37[illegible] 504
9783	45292		03687	E	18	W 7771	0	1	23	815647 NUMBER 2
9783	45292		03686	E	18	W 7771	0	1	23	815647 NUMBER 1
243	07151		00098	B	18		1	1	1	56
285	07914		03218	E	30	W 285	8	1	14	B09102
285	07914		00111	D	18		1	1	1	65
285	07914		03219	E	30	W 285	1	1	15	B09102
285	07914		03220	E	30	W 285	1	1	1	B09102
341	08582		00130	D	18		1	1	1	67
341	08582		03221	E	30	W 285	8	1	14	B09102
341	08582		03222	E	30	W 285	1	1	15	B09102
341	08582		03223	E	30	W 285	1	1	16	B09102
492	10408		00169	B	18		1	1	1	67
492	10408		03224	E	30	W 285	8	1	14	B09102
492	10408		03225	E	30	W 285	1	1	15	B09102
492	10408		03226	E	30	W 285	1	1	16	B09102
554	11049		00414	B	18		3	8	1	120
719	12143		00226	B	18		1	8	2	167
1159	15934		00417	B	18		1	8	2	246 ENLT OF EUREKA P NO 141
1162	15948		00416	B	18		1	8	24	246 CPD
1162	15948		00419	B	18		1	8	2	240
1162	15948		00418	B	18		3	8	2	240
1162	15948		00415	B	18		1	8	25	245
1565	19868		00343	D	18		1	1	2	513
1568	19868		00444	B	18		1	8	2	
1568	19868		00443	B	18		1	8	2	
2164	23602		00091	B	18		1	8	2	469 543
2591	26815		00384	D	18		1	1	2	449 540
5053	38313		00520	B	18	3635	3	1 9	2	
5087	38399		00534	B	18	3635	1	1	2	
5613	39538		00519	B	18	3635	3	1	2	
5673	39671		00510	B	18	3635	1	1	2	
6106	40822		00515	B	18	3635	3	1 5 9	2	
1566	19868		00344	D	03		1	1	2	403 518
48	04199		00004	B	18		1	1	1	13
107	04990		00027	B	18		1	1	1	26
132	05478		00041	B	18		1	1	1	33
179	05996		00065	B	18		1	1	1	36
243	07151		00093	B	18		1	1	1	52
282	07851		00108	B	18		1	1	1	52
294	08005		00112	B	18		1	1	1	12
335	08551		00125	B	11		1	1	1	79
559	11088		00199	B	18		1	1	1	121
599	11473		00205	B	18		1	1	1	80 NO ADDITIONAL WATER GRANTED
242	07092		00092	B	18		1	1	1	51
541	10897		00190	BA	18		1	1	1	115
733	12398		00222	B	18		1	1	2	206
1935	21704		00401	C	03		3	1	2	550

Figure 5.--Water rights tabulation report - Page B.

DIVISION 1   DISTRICT 08   ANNUAL WATER DIVERSION REPORT   IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002)   AGENT/OFFICIAL: CITY OF DENVER
OWNER
DENVER, COLO.   MEAS DEVICE: 36" 90" V
RECORDER: BIF

SOURCE STREAM: SOUTH PLATTE RIVER (001)   ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

DIVERSION CHARACTERISTICS: SOURCE- RIVER (1), USE- MUNICIPAL (2), FROM- ( ), TYPE- ( )

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/	128.000*	114.000*	45.000*	52.000*	67.000*	142.000*	97.000*	55.000*	52.000*	54.000*	47.000*	2.000*	/ 1
2/	141.000*	101.000*	37.000*	48.000*	60.000*	116.000*	99.000*	55.000*	52.000*	55.000*	45.000*	2.000*	/ 2
3/	123.000*	109.000*	48.000*	40.000*	64.000*	103.000*	129.000*	61.000*	52.000*	53.000*	47.000*	2.000*	/ 3
4/	119.000*	101.000*	53.000*	70.000*	53.000*	74.000*	127.000*	55.000*	52.000*	52.000*	43.000*	2.000*	/ 4
5/	121.000*	96.000*	14.000*	75.000*	44.000*	.000*	65.000*	55.000*	52.000*	53.000*	35.000*	2.000*	/ 5
6/	114.000*	85.000*	29.000*	56.000*	49.000*	6.000*	70.000*	61.000*	53.000*	55.000*	35.000*	2.000*	/ 6
7/	111.000*	86.000*	19.000*	37.000*	71.000*	69.000*	90.000*	61.000*	55.000*	55.000*	43.000*	2.000*	/ 7
8/	110.000*	180.000*	30.000*	36.000*	87.000*	46.000*	97.000*	61.000*	55.000*	26.000*	47.000*	2.000*	/ 8
9/	110.000*	91.000*	12.000*	41.000*	87.000*	35.000*	92.000*	61.000*	55.000*	30.000*	47.000*	2.000*	/ 9
10/	99.000*	98.000*	.000*	47.000*	41.000*	40.000*	92.000*	61.000*	55.000*	42.000*	40.000*	2.000*	/10
11/	120.000*	74.000*	8.000*	31.000*	.000*	40.000*	92.000*	61.000*	55.000*	43.000*	45.000*	2.000*	/11
12/	96.000*	85.000*	.000*	54.000*	33.000*	140.000*	77.000*	61.000*	55.000*	43.000*	47.000*	2.000*	/12
13/	87.000*	76.000*	18.000*	63.000*	83.000*	75.000*	92.000*	61.000*	52.000*	45.000*	31.000*	2.000*	/13
14/	103.000*	79.000*	6.000*	59.000*	77.000*	124.000*	64.000*	61.000*	52.000*	47.000*	47.000*	2.000*	/14
15/	121.000*	79.000*	4.000*	51.000*	58.000*	86.000*	2.000*	61.000*	52.000*	47.000*	37.000*	2.000*	/15
16/	121.000*	72.000*	11.000*	68.000*	67.000*	136.000*	61.000*	61.000*	52.000*	47.000*	33.000*	2.000*	/16
17/	75.000*	84.000*	23.000*	75.000*	70.000*	129.000*	61.000*	61.000*	21.000*	47.000*	47.000*	2.000*	/17
18/	83.000*	77.000*	38.000*	73.000*	59.000*	160.000*	53.000*	55.000*	15.000*	47.000*	38.000*	2.000*	/18
19/	82.000*	74.000*	45.000*	74.000*	55.000*	205.000*	57.000*	55.000*	20.000*	47.000*	35.000*	2.000*	/19
20/	83.000*	53.000*	33.000*	54.000*	57.000*	178.000*	55.000*	55.000*	43.000*	47.000*	36.000*	2.000*	/20
21/	81.000*	46.000*	48.000*	70.000*	55.000*	144.000*	55.000*	55.000*	29.000*	47.000*	19.000*	2.000*	/21
22/	68.000*	45.000*	47.000*	78.000*	66.000*	144.000*	55.000*	55.000*	80.000*	47.000*	13.000*	2.000*	/22
23/	74.000*	18.000*	56.000*	64.000*	92.000*	127.000*	55.000*	55.000*	58.000*	53.000*	12.000*	2.000*	/23
24/	49.000*	63.000*	39.000*	66.000*	117.000*	153.000*	55.000*	55.000*	55.000*	47.000*	13.000*	2.000*	/24
25/	76.000*	47.000*	35.000*	65.000*	143.000*	168.000*	55.000*	55.000*	44.000*	47.000*	21.000*	2.000*	/25
26/	78.000*	53.000*	44.000*	34.000*	128.000*	99.000*	55.000*	53.000*	47.000*	47.000*	15.000*	2.000*	/26
27/	17.000*	80.000*	43.000*	56.000*	128.000*	98.000*	55.000*	52.000*	124.000*	46.000*	12.000*	2.000*	/27
28/	19.000*	64.000*	32.000*	45.000*	148.000*	99.000*	55.000*	52.000*	47.000*	47.000*	11.000*	46.000*	/28
29/	82.000*	57.000*	28.000*		108.000*	100.000*	55.000*	52.000*	50.000*	47.000*	8.000*	19.000*	/29
30/	112.000*	62.000*	34.000*		101.000*	99.000*	54.000*	52.000*	55.000*	47.000*	14.000*	74.000*	/30
31/		37.000*	41.000*		111.000*		63.000*		55.000*	47.000*		74.000*	/31
TOT (SFD)	2803.00	2386.00	920.00	1582.00	2379.00	3135.00	2184.00	1714.00	1594.00	1457.00	963.00	267.00	
AVG (SFD)	93.433	76.968	31.724	56.500	79.300	108.103	70.452	57.133	51.419	47.000	32.100	8.613	
TOT (AF)	5559.9	4724.3	1821.6	3132.4	4710.4	6207.3	4324.3	3393.7	3156.1	2884.9	1906.7	528.7	

ANNUAL TOTAL: 21,384.0 (SFD)
ANNUAL AVERAGE: 59.235 (SFD)
ANNUAL TOTAL: 42,340.3 (AF)

* INDICATES OBSERVED DATA, U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

- - - - - - - - - - - - - - - -

DATE FIRST USED: 11/01/1976
DATE LAST USED: 10/31/1977

Figure 6.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002) AGENT/OFFICIAL: CITY OF DENVER
OWNER
DENVER, COLO.

SOURCE STREAM: SOUTH PLATTE RIVER (001)

MEAS DEVICE: 36" 90" V
RECORDER: BIF
ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

DIVERSION CHARACTERISTICS: SOURCE- RIVER (1), USE- MUNICIPAL (2), FROM- METRO SEWER EXCH (0700), TYPE- ( )

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/							28.000*	14.000*	45.000*	.000*	38.000*	7.000*	/ 1
2/	3.000*						34.000*	23.000*	52.000*	24.000*	.000*	8.000*	/ 2
3/	.000*						34.000*	61.000*	26.000*	22.000*	4.000*	5.000*	/ 3
4/							34.000*	68.000*	32.000*	31.000*	.000*	.000*	/ 4
5/							.000*	56.000*	39.000*	37.000*	.000*	5.000*	/ 5
6/								43.000*	46.000*	46.000*	.000*	10.000*	/ 6
7/							42.000*	59.000*	55.000*	3.000*	5.000*	16.000*	/ 7
8/							35.000*	19.000*	39.000*	.000*	21.000*	21.000*	/ 8
9/							62.000*	31.000*	15.000*		8.000*	18.000*	/ 9
10/							56.000*	48.000*	36.000*		.000*	22.000*	/10
11/						9.000*	52.000*	49.000*	11.000*	44.000*	.000*	24.000*	/11
12/						24.000*	45.000*	59.000*	9.000*	57.000*	6.000*	21.000*	/12
13/						24.000*	19.000*	61.000*	22.000*	46.000*	.000*	37.000*	/13
14/						32.000*	45.000*	50.000*	19.000*	43.000*	4.000*	41.000*	/14
15/						62.000*	.000*	21.000*	14.000*	54.000*	.000*	39.000*	/15
16/						55.000*	15.000*	37.000*	6.000*	56.000*	.000*	47.000*	/16
17/						55.000*	62.000*	45.000*	.000*	64.000*	12.000*	35.000*	/17
18/						45.000*	.000*	57.000*		74.000*	.000*	47.000*	/18
19/						.000*	44.000*	57.000*		79.000*		38.000*	/19
20/							53.000*	39.000*		54.000*		48.000*	/20
21/							62.000*	65.000*		77.000*		39.000*	/21
22/							56.000*	56.000*		64.000*		44.000*	/22
23/							65.000*	41.000*		66.000*		47.000*	/23
24/							67.000*	26.000*	12.000*	57.000*		44.000*	/24
25/							66.000*	28.000*	.000*	38.000*		68.000*	/25
26/						15.000*	69.000*	40.000*		23.000*		61.000*	/26
27/						27.000*	79.000*	26.000*		.000*		65.000*	/27
28/						29.000*	68.000*	23.000*		3.000*		30.000*	/28
29/						29.000*	53.000*	46.000*	11.000*	25.000*		.000*	/29
30/						22.000*	16.000*	25.000*	14.000*	35.000*		13.000*	/30
31/							29.000*		3.000*	40.000*		.000*	/31
TOT (SFD)	3.00	.00	.00	.00	.00	428.00	1290.00	1273.00	506.00	1162.00	98.00	900.00	
AVG (SFD)	3.000	.000	.000	.000	.000	32.923	47.778	42.433	25.300	44.692	12.250	32.143	
TOT (AF)	5.9	.0	.0	.0	.0	847.4	2554.2	2520.5	1001.9	2300.8	194.0	1782.0	

ANNUAL TOTAL: 5,660.0 (SFD)
ANNUAL AVERAGE: 36.993 (SFD)
ANNUAL TOTAL: 11,206.8 (AF)

* INDICATES OBSERVED DATA. U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

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DATE FIRST USED: 11/02/1976
DATE LAST USED: 10/30/1977

Figure 7.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002) AGENT/OFFICIAL: CITY OF DENVER MEAS DEVICE: 36" 90" V
OWNER RECORDER: BIF
SOURCE STREAM: SOUTH PLATTE RIVER (001) DENVER, COLO. ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

DIVERSION CHARACTERISTICS: SOURCE- RIVER (1), USE- MUNICIPAL (2), FROM- SODA LAKES EX (3815), TYPE- ( )

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/													/ 1
2/													/ 2
3/													/ 3
4/													/ 4
5/													/ 5
6/													/ 6
7/													/ 7
8/													/ 8
9/													/ 9
10/													/10
11/													/11
12/													/12
13/													/13
14/													/14
15/													/15
16/													/16
17/										5.000*			/17
18/										22.000*			/18
19/										25.000*			/19
20/										25.000*			/20
21/										25.000*			/21
22/										25.000*			/22
23/										25.000*			/23
24/										25.000*			/24
25/										25.000*			/25
26/										6.000*			/26
27/										.000*			/27
28/													/28
29/													/29
30/													/30
31/													/31
TOT (SFD)	.00	.00	.00	.00	.00	.00	.00	.00	.00	208.00	.00	.00	
AVG (SFD)	.000	.000	.000	.000	.000	.000	.000	.000	.000	20.800	.000	.000	
TOT (AF)	.0	.0	.0	.0	.0	.0	.0	.0	.0	411.8	.0	.0	

ANNUAL TOTAL: 208.0 (SFD)
ANNUAL AVERAGE: 20.800 (SFD)
ANNUAL TOTAL: 411.8 (AF)

* INDICATES OBSERVED DATA, U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

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DATE FIRST USED: 08/17/1977
DATE LAST USED: 08/26/1977

Figure 8.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 — ANNUAL WATER DIVERSION REPORT — IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002)
AGENT/OFFICIAL: CITY OF DENVER
OWNER
DENVER, COLO.
MEAS DEVICE: 36" 90" V
RECORDER: BIF
ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

SOURCE STREAM: SOUTH PLATTE RIVER (001)

DIVERSION CHARACTERISTICS: SOURCE- RESERVOIR (2), USE- MUNICIPAL (2), FROM- CHEESMAN RESERVOIR (3550), TYPE- ( )

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/			46.000*	54.000*	5.000*								/ 1
2/			51.000*	49.000*	5.000*								/ 2
3/			43.000*	44.000*	.000*								/ 3
4/			42.000*	39.000*									/ 4
5/			59.000*	39.000*									/ 5
6/			45.000*	39.000*									/ 6
7/			56.000*	39.000*									/ 7
8/			48.000*	34.000*									/ 8
9/			48.000*	34.000*									/ 9
10/			54.000*	34.000*									/10
11/			56.000*	44.000*									/11
12/			42.000*	54.000*									/12
13/			53.000*	54.000*									/13
14/			81.000*	54.000*									/14
15/			82.000*	54.000*									/15
16/		.000*	80.000*	49.000*									/16
17/			76.000*	44.000*									/17
18/			77.000*	44.000*									/18
19/			77.000*	34.000*									/19
20/			78.000*	34.000*									/20
21/		6.000*	76.000*	34.000*									/21
22/		14.000*	78.000*	34.000*									/22
23/		40.000*	78.000*	24.000*									/23
24/		14.000*	78.000*	15.000*									/24
25/		38.000*	73.000*	15.000*									/25
26/		44.000*	73.000*	15.000*									/26
27/		37.000*	73.000*	15.000*									/27
28/		27.000*	73.000*	15.000*									/28
29/		43.000*	68.000*										/29
30/		35.000*	63.000*										/30
31/		43.000*	59.000*										/31
TOT (SFD)	.00	341.00	1986.00	1037.00	10.00	.00	.00	.00	.00	.00	.00	.00	
AVG (SFD)	.000	31.000	64.065	37.036	5.000	.000	.000	.000	.000	.000	.000	.000	
TOT (AF)	.0	675.2	3932.3	2053.3	19.8	.0	.0	.0	.0	.0	.0	.0	

ANNUAL TOTAL: 3,374.0 (SFD)
ANNUAL AVERAGE: 46.861 (SFD)
ANNUAL TOTAL: 6,680.5 (AF)

* INDICATES OBSERVED DATA, U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

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DATE FIRST USED: 12/21/1976
DATE LAST USED: 03/02/1977

Figure 9.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002) AGENT/OFFICIAL: CITY OF DENVER OWNER DENVER, COLO. MEAS DEVICE: 36" 90" V

SOURCE STREAM: SOUTH PLATTE RIVER (001)

RECORDER: BIF
ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

DIVERSION CHARACTERISTICS: SOURCE- TRANSBASIN(4), USE- MUNICIPAL (2), FROM- ROBERTS TUNNEL (0653), TYPE- ( )

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/	30.000*	93.000*	86.000*	92.000*	90.000*	86.000*	60.000*	142.000*	217.000*	212.000*	204.000*	333.000*	/ 1
2/	27.000*	93.000*	86.000*	92.000*	90.000*	86.000*	60.000*	230.000*	211.000*	214.000*	181.000*	333.000*	/ 2
3/	123.000*	93.000*	86.000*	93.000*	90.000*	82.000*	120.000*	221.000*	233.000*	214.000*	152.000*	333.000*	/ 3
4/	120.000*	93.000*	89.000*	93.000*	90.000*	58.000*	120.000*	199.000*	234.000*	213.000*	152.000*	333.000*	/ 4
5/	120.000*	93.000*	90.000*	93.000*	90.000*	.000*	130.000*	205.000*	219.000*	213.000*	152.000*	308.000*	/ 5
6/	120.000*	93.000*	90.000*	93.000*	90.000*		130.000*	132.000*	217.000*	215.000*	152.000*	284.000*	/ 6
7/	120.000*	89.000*	90.000*	93.000*	92.000*		171.000*	31.000*	205.000*	145.000*	100.000*	259.000*	/ 7
8/	120.000*	89.000*	90.000*	90.000*	92.000*		171.000*	66.000*	187.000*	126.000*	48.000*	245.000*	/ 8
9/	120.000*	89.000*	90.000*	90.000*	92.000*	100.000*	171.000*	81.000*	210.000*	126.000*	48.000*	245.000*	/ 9
10/	130.000*	89.000*	90.000*	90.000*	92.000*	100.000*	171.000*	96.000*	211.000*	143.000*	48.000*	245.000*	/10
11/	120.000*	89.000*	92.000*	90.000*	92.000*	100.000*	171.000*	141.000*	212.000*	171.000*	43.000*	245.000*	/11
12/	120.000*	89.000*	92.000*	90.000*	92.000*	100.000*	171.000*	107.000*	212.000*	171.000*	48.000*	245.000*	/12
13/	120.000*	89.000*	92.000*	90.000*	92.000*	228.000*	171.000*	12.000*	212.000*	171.000*	47.000*	245.000*	/13
14/	120.000*	89.000*	92.000*	90.000*	92.000*	143.000*	152.000*	12.000*	221.000*	171.000*	47.000*	286.000*	/14
15/	120.000*	86.000*	92.000*	90.000*	92.000*	143.000*	209.000*	82.000*	212.000*	170.000*	71.000*	286.000*	/15
16/	71.000*	86.000*	92.000*	90.000*	92.000*	143.000*	73.000*	120.000*	224.000*	171.000*	96.000*	286.000*	/16
17/	71.000*	86.000*	92.000*	90.000*	92.000*	77.000*	65.000*	115.000*	237.000*	187.000*	113.000*	286.000*	/17
18/	71.000*	86.000*	92.000*	90.000*	92.000*	77.000*	186.000*	181.000*	235.000*	187.000*	143.000*	286.000*	/18
19/	71.000*	86.000*	92.000*	90.000*	84.000*	.000*	200.000*	184.000*	235.000*	96.000*	143.000*	286.000*	/19
20/	71.000*	86.000*	92.000*	90.000*	84.000*		221.000*	177.000*	232.000*	96.000*	119.000*	286.000*	/20
21/	71.000*	86.000*	92.000*	90.000*	84.000*		213.000*	80.000*	285.000*	48.000*	95.000*	286.000*	/21
22/	71.000*	86.000*	92.000*	90.000*	84.000*		158.000*	14.000*	155.000*	48.000*	170.000*	286.000*	/22
23/	71.000*	86.000*	92.000*	90.000*	100.000*	41.000*	174.000*	29.000*	85.000*	53.000*	220.000*	286.000*	/23
24/	96.000*	86.000*	92.000*	90.000*	100.000*	80.000*	206.000*	17.000*	38.000*	.000*	239.000*	286.000*	/24
25/	96.000*	86.000*	92.000*	90.000*	95.000*	40.000*	206.000*	19.000*	66.000*		239.000*	261.000*	/25
26/	96.000*	86.000*	92.000*	90.000*	95.000*	20.000*	207.000*	37.000*	67.000*	48.000*	239.000*	238.000*	/26
27/	96.000*	86.000*	92.000*	90.000*	95.000*	40.000*	195.000*	14.000*	.000*	119.000*	239.000*	213.000*	/27
28/	96.000*	86.000*	92.000*	90.000*	95.000*	20.000*	208.000*	25.000*	29.000*	238.000*	239.000*	213.000*	/28
29/	96.000*	86.000*	93.000*		95.000*	20.000*	5.000*	112.000*	51.000*	238.000*	261.000*	166.000*	/29
30/	91.000*	86.000*	92.000*		86.000*	60.000*	5.000*	211.000*	32.000*	238.000*	286.000*	166.000*	/30
31/		86.000*	92.000*		86.000*		.000*		184.000*	252.000*		166.000*	/31
TOT (SFD)	2865.00	2732.00	2820.00	2539.00	2827.00	1844.00	4500.00	3092.00	5368.00	4694.00	4334.00	8222.00	
AVG (SFD)	95.500	88.129	90.968	90.679	91.194	83.818	150.000	103.067	178.933	161.862	144.467	265.226	
TOT (AF)	5672.7	5409.4	5583.6	5027.2	5597.5	3651.1	8910.0	6122.2	10628.6	9294.1	8581.3	16279.6	

ANNUAL TOTAL: 45.837.0 (SFD)
ANNUAL AVERAGE: 129.850 (SFD)
ANNUAL TOTAL: 90.757.3 (AF)

* INDICATES OBSERVED DATA, U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

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DATE FIRST USED: 11/01/1976
DATE LAST USED: 10/31/1977

Figure 10.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

DAILY WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME: DENVER INTAKE (01002) AGENT/OFFICIAL: CITY OF DENVER
OWNER
DENVER, COLO.

SOURCE STREAM: SOUTH PLATTE RIVER (001)

MEAS DEVICE: 36" 90" V
RECORDER: BIF
ESTIMATED CAPACITY: 400.00
DECREED CAPACITY:

DAILY TOTAL FROM ALL SOURCES FOR ALL USES

	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	
1/	158.000*	207.000*	177.000*	198.000*	162.000*	228.000*	185.000*	211.000*	314.000*	266.000*	289.000*	342.000*	/ 1
2/	171.000*	194.000*	174.000*	189.000*	155.000*	202.000*	193.000*	308.000*	315.000*	293.000*	226.000*	343.000*	/ 2
3/	246.000*	202.000*	177.000*	177.000*	154.000*	185.000*	283.000*	343.000*	311.000*	289.000*	203.000*	340.000*	/ 3
4/	239.000*	194.000*	184.000*	202.000*	143.000*	132.000*	281.000*	322.000*	318.000*	296.000*	195.000*	335.000*	/ 4
5/	241.000*	189.000*	163.000*	207.000*	134.000*	.000*	195.000*	316.000*	310.000*	303.000*	187.000*	315.000*	/ 5
6/	234.000*	178.000*	164.000*	188.000*	139.000*	6.000*	200.000*	236.000*	316.000*	316.000*	187.000*	296.000*	/ 6
7/	231.000*	175.000*	165.000*	169.000*	163.000*	69.000*	303.000*	151.000*	315.000*	203.000*	148.000*	277.000*	/ 7
8/	230.000*	269.000*	168.000*	160.000*	179.000*	46.000*	303.000*	146.000*	281.000*	152.000*	116.000*	268.000*	/ 8
9/	230.000*	180.000*	150.000*	165.000*	179.000*	135.000*	325.000*	173.000*	280.000*	156.000*	103.000*	265.000*	/ 9
10/	229.000*	187.000*	144.000*	171.000*	133.000*	140.000*	319.000*	205.000*	302.000*	185.000*	88.000*	269.000*	/10
11/	240.000*	163.000*	156.000*	165.000*	92.000*	149.000*	315.000*	251.000*	278.000*	258.000*	88.000*	271.000*	/11
12/	216.000*	174.000*	134.000*	198.000*	125.000*	264.000*	293.000*	227.000*	276.000*	271.000*	101.000*	268.000*	/12
13/	207.000*	165.000*	163.000*	207.000*	175.000*	327.000*	282.000*	134.000*	286.000*	262.000*	78.000*	284.000*	/13
14/	223.000*	168.000*	179.000*	203.000*	169.000*	299.000*	261.000*	123.000*	292.000*	261.000*	98.000*	329.000*	/14
15/	241.000*	165.000*	178.000*	195.000*	150.000*	291.000*	211.000*	164.000*	278.000*	271.000*	108.000*	327.000*	/15
16/	192.000*	158.000*	183.000*	207.000*	159.000*	334.000*	149.000*	218.000*	282.000*	274.000*	129.000*	335.000*	/16
17/	146.000*	170.000*	191.000*	209.000*	162.000*	261.000*	188.000*	221.000*	258.000*	303.000*	172.000*	323.000*	/17
18/	154.000*	163.000*	207.000*	207.000*	151.000*	282.000*	239.000*	293.000*	250.000*	330.000*	181.000*	335.000*	/18
19/	153.000*	160.000*	214.000*	198.000*	139.000*	205.000*	301.000*	296.000*	255.000*	247.000*	178.000*	326.000*	/19
20/	154.000*	139.000*	203.000*	178.000*	141.000*	178.000*	329.000*	271.000*	275.000*	222.000*	155.000*	336.000*	/20
21/	152.000*	138.000*	216.000*	194.000*	139.000*	144.000*	330.000*	200.000*	314.000*	197.000*	114.000*	327.000*	/21
22/	139.000*	145.000*	217.000*	202.000*	150.000*	144.000*	269.000*	125.000*	235.000*	184.000*	183.000*	332.000*	/22
23/	145.000*	144.000*	226.000*	178.000*	192.000*	168.000*	294.000*	125.000*	143.000*	197.000*	232.000*	335.000*	/23
24/	145.000*	163.000*	209.000*	171.000*	217.000*	233.000*	328.000*	98.000*	105.000*	129.000*	252.000*	332.000*	/24
25/	172.000*	171.000*	200.000*	170.000*	238.000*	208.000*	327.000*	102.000*	110.000*	110.000*	260.000*	331.000*	/25
26/	174.000*	183.000*	209.000*	139.000*	223.000*	134.000*	331.000*	130.000*	114.000*	124.000*	254.000*	301.000*	/26
27/	113.000*	203.000*	208.000*	161.000*	223.000*	165.000*	329.000*	92.000*	124.000*	165.000*	251.000*	280.000*	/27
28/	115.000*	177.000*	197.000*	150.000*	243.000*	148.000*	331.000*	100.000*	76.000*	288.000*	250.000*	289.000*	/28
29/	178.000*	186.000*	189.000*		203.000*	149.000*	113.000*	210.000*	112.000*	310.000*	269.000*	185.000*	/29
30/	203.000*	183.000*	189.000*		187.000*	181.000*	75.000*	288.000*	101.000*	320.000*	300.000*	253.000*	/30
31/		166.000*	192.000*		197.000*		92.000*		242.000*	339.000*		240.000*	/31
TOT (SFD)	5671.00	5459.00	5726.00	5158.00	5216.00	5407.00	7974.00	6079.00	7468.00	7521.00	5395.00	9389.00	
AVG (SFD)	189.033	176.097	184.710	184.214	168.258	186.448	257.226	202.633	240.903	242.613	179.833	302.871	
TOT (AF)	11228.6	10808.8	11337.5	10212.8	10327.7	10705.9	15788.5	12036.4	14786.6	14891.6	10682.1	18590.2	

ANNUAL TOTAL: 76,463.0 (SFD)
ANNUAL AVERAGE: 210.063 (SFD)
ANNUAL TOTAL: 151,396.7 (AF)

* INDICATES OBSERVED DATA. U INDICATES USER SUPPLIED DATA
ALL OTHER DATA IS INTERPRETED FROM PREVIOUS OBSERVED VALUE

WATER COMMISSIONER

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DATE FIRST USED: 11/01/1976
DATE LAST USED: 10/31/1977

Figure 11.--Annual daily water diversion report.

DIVISION 1 DISTRICT 08 ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

INFREQUENT WATER DIVERSIONS BY STRUCTURE

STRUCTURE NAME	(IDENT)	SOURCE STREAM / - - - - DIVERSION CHARACTERISTICS - - - - SOURCE	FROM	(STRNO) AGENT/OFFICIAL NAME / USE	TYPE	TITLE / YEAR	MON	AMOUNT	ADDRESS / UNITS	DAYS	DATA TYPE	DECREED CAP. (CODE)
	(00862),			(000),		,			,			.
		RIVER (1)	( )	OTHER (0)	( )	1976	12	2.000	CFS(C)	31	AVG DAILY AMT-MONTH	(1)
	(00864),			(000),		,			,			.
		RIVER (1)	( )	OTHER (0)	( )	1976	12	8.500	CFS(C)	31	AVG DAILY AMT-MONTH	(1)
GREEN MEADOW D	(01269),	JARRE CREEK		(028), ESME WILLIAMS		, OWNER			, SEDALIA, COLO.			.
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.100	CFS(C)	60	AVG DAILY AMT-SEASON	(3)
BUNTAIN D	(01270),	JARRE CREEK		(028), CHESTER HIER		, OWNER			, SEDALIA, COLO.			.
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.250	CFS(C)	50	AVG DAILY AMT-SEASON	(3)
ELISA LINHART D	(01306),	LEE GULCH		(030), SO. SUBR. REC.		, OWNER			, LITTLETON, COLO.			.
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.300	CFS(C)	200	AVG DAILY AMT-SEASON	(3)
F.L. GREEN 2 D	(01337),	WIERS GULCH		(053), E. BURNHAM		, OWNER			, DENVER, COLO.			.
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.200	CFS(C)	60	AVG DAILY AMT-SEASON	(3)
NORMAN PIPELINE	(01483),	WILLOW CREEK		(054), JULIA M. NORMAN		, OWNER			, LITTLETON, COLORADO			1.00
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.200	CFS(C)	90	AVG DAILY AMT-SEASON	(3)
PICKENS SPRING	(01490),	SPRING		(096), EDWARD E. PICKENS		, OWNER			, FRANKTOWN, COLORADO			.33
		RIVER (1)	( )	IRRIGATION(1)	( )	1977	00	.020	CFS(C)	30	AVG DAILY AMT-SEASON	(3)
COLUMBINE CC AUG PLN	(02500),			(000),		,			,			.
		RIVER (1)	(1007)	OTHER (0)	( )	1977	00	503.770	AF (A)		TOTAL AMT FOR SEASON	(4)
BUCK POND	(03362),	LITTLE WILLOW CREEK		(033), DOUGLAS N. BUCK		, OWNER			, LITTLETON, COLORADO			1.00
		GRND WATER(3)	( )	IRRIGATION(1)	( )	1977	00	.200	CFS(C)	200	AVG DAILY AMT-SEASON	(3)
WILSON RES.	(03363),	SANDERSON GULCH		(044), L. WILSON		, OWNER			, DENVER, COLORADO			25.50
		RESERVOIR (2)	( )	IRRIGATION(1)	)	1977	00	.500	CFS(C)	25	AVG DAILY AMT-SEASON	(3)
CHATFIELD RES.	(03514),	SOUTH PLATTE RIVER		(001), CORPS OF ENGINEERS		, OWNER			, OMAHA, NEB.			.
		RESERVOIR (2)	( )	IRRIGATION(1)	( )	1977	00	1548.000	AF (A)		TOTAL AMT FOR SEASON	(4)
		RESERVOIR (2)	( )	RECREATION(5)	( )	1977	00	1548.000	AF (A)	30	TOTAL AMT FOR SEASON	(4)
WAUCUNDAH RES A PUMP	(03516),	BEAR SPRINGS CREEK		(005), COLO. WESTERN		, OWNER			, LARKSPUR, COLO.			.
		RESERVOIR (2)	( )	IRRIGATION(1)	( )	1977	00	310.000	CFS(C)		TOTAL AMT FOR SEASON	(4)
WELLINGTON LAKE	(03829),			(000),		,			,			.
		RIVER (1)	( )	OTHER (0)	( )	1976	12	653.000	AF (A)		TOTAL AMT FOR MONTH	(2)
DEVINNEY RES	(03945),	GULCH		(024), ROCKMONT COLL:		, OWNER			, LAKEWOOD, COLO.			.
		RESERVOIR (2)	( )	IRRIGATION(1)	( )	1977	00	.017	AF (A)		TOTAL AMT FOR SEASON	(4)
DEVINNY RES 2 A PUMP	(03946),	GULCH		(024), BRAEWOOD CO.		, OWNER			, AURORA, COLO.			.
		RESERVOIR (2)	( )	IRRIGATION(1)	( )	1977	00	.009	AF (A)		TOTAL AMT FOR SEASON	(4)
ARLINGTON PL	(05003),	GROUNDWATER		(099), DENVER COUNTRY CLUB		, OWNER			, DENVER, COLO.			.

Figure 12.--Annual infrequent water diversion report.

DIVISION 1 DISTRICT 08

ANNUAL WATER DIVERSION REPORT
SUMMARY OF WATER DIVERSIONS

IRRIGATION YEAR 1977

STRUCTURE NAME	(IDENT)	FIRST PAGE	FIRST DAY USED	LAST DAY USED	DAYS WATER CARRIED	AVG CFS	TOTAL ACRE FT DIVERTED	FROM RIVER	FROM RES	FROM GW	FROM TB	FROM NS	TOTAL TO STORAGE	TOTAL TO IRRIG	ACRES IRRIG	AF PER ACRE
COUCH D	(01147)	NO RECORD THIS YEAR. REASON - STRUCTURE NOT USEABLE														
COX WELL 6227F	(05051)	99C	04/30/1977	09/15/1977	43	1.000	85			85				85	11	7.7
CRAIG D	(01218)	44C	05/26/1977	08/15/1977	66	1.674	219	219						219	60	3.6
CRAWFORD D	(01413)	NO RECORD THIS YEAR. REASON - STRUCTURE NOT USEABLE														
CROWLEY WELLS	(05023)	2D	11/01/1976	10/31/1977	365	.100	72			72				72		
	WC COMMENT:	GREENHOUSE SEE ID SHEET														
CURTIS D	(01215)	43C	05/05/1977	08/14/1977	51	1.392	141	141						141	60	2.3
DAD CLARK 3 D	(01296)														25	
	WC COMMENT:	SEE ID SHEET														
DAHLBERG WELL #1	(05159)	117C	05/29/1977	08/01/1977	36	.250	18			18				18	15	1.2
DAKAN D	(01241)	NO RECORD THIS YEAR. REASON - STRUCTURE NOT USEABLE														
DARDANO WELLS 1-2	(05138)	4D	11/01/1976	10/31/1977	365	.050	36			36				36		
	WC COMMENT:	GREENHOUSE SEE ID SHEET														
DAVIDSON DITCH	(01376)	NO RECORD THIS YEAR. REASON - STRUCTURE NOT USEABLE														
	WC COMMENT:	TRANSFER TO WILLIAMSON WELLS 1,2,4 5013														
DEER CREEK CANON D	(01121)	NO RECORD THIS YEAR. REASON - STRUCTURE NOT USEABLE														
	WC COMMENT:	WASHED OUT 1969 PART OF AUGMENTATION PLAN W-7390														
DENVER INTAKE	(01002)	7C	11/01/1976	10/31/1977	364	210.063	151397	53959	6681		90757					
DENVER WELLS 1-18	(05102)	NO RECORD THIS YEAR. REASON - NO WATER WANTED														
	WC COMMENT:	BROUGHT PUMPS TO OPERATING CONDITION														
DENVER WELLS 30-33	(05142)	NO RECORD THIS YEAR. REASON - NO WATER WANTED														
	WC COMMENT:	MUNICIPAL USE SUPPLEMENTAL SUPPLY														
DENVER WH WELL 1 1-2367F	(05191)	5D	11/01/1976	10/31/1977	365	.200	145			145				145		
	WC COMMENT:	GREENHOUSE SEE ID SHEET														
DERBY RES	(03502)															
	WC COMMENT:	INDUSTRIAL USE CHARGED AT SOURCE N CALC HIGHLINE 1004														
	WC COMMENT:	COLORADO HIGHLINE														
DEVINNEY RES	(03945)	1D	11/01/1976	10/31/1977	365											
	WC COMMENT:	SEE ID SHEET														
DEVINNY RES 2 A PUMP	(03946)	1D	11/01/1976	10/31/1977	365											
	WC COMMENT:	SEE ID SHEET														
DIXON WELL FIELD	(05004)	2D	11/01/1976	10/31/1977	160	8.500	2693			2693				2693	500	5.4
	WC COMMENT:	SEE ID SHEET														

Figure 13.--Annual summary water diversion report.

ANNUAL WATER DIVERSION REPORT IRRIGATION YEAR 1977

SUMMARY OF WATER USES

WD	STORAGE	IRRIG	MUN	COMM	IND	RECR	FISH	FIRE	DOM	STOCK	OTHER	TOTAL
07	13098	86131	2958		31241						26617	160046
08		68005	104772	18066	45183	1548					5372	332947
09	2205	16034	3421						879			22541
23		24871	13810			3613					958	43253
TOTAL	15304	195042	214961	18066	76424	5161			879		32948	558788

Figure 14.--Annual water diversion use summary report.

WATER DIVERSION CODES

S SOURCE - the physical source of water

1. River, Stream or Creek
2. Reservoir Storage
3. Ground Water
4. Transbasin
5. Non-Stream (wastes, seeps, non-trib, springs, etc.)

U USE - the actual use of water

0. Storage
1. Irrigation
2. Municipal
3. Commercial
4. Industrial
5. Recreation
6. Fishery
7. Fire
8. Domestic
9. Stock
10. Other

T TYPE - used to classify special water

1. Exchange
2. Trade (a particular kind of exchange)
3. Carrier
4. Alternate Point of Diversion
5. Re-used
6. Replacement to River
7. Released to River
8. Released to System
9. User-Supplied-Information

Figure 15.--Codes for water diversion identifiers.

the affected Water Divisions and the Denver Office. It is surprising how many conflicts in data arise in this area. It is not uncommon for a structure to be involved in several court actions such as transfers, alternate points of diversion, or newly decreed (supplemental) water; and it is not at all uncommon for these different actions to refer to the same structure by slightly different names or locations. This can be especially true when the structure lies in a geographical area that has been resurveyed.

The Division has already been involved in a study of the White River basin where the water rights and water diversion records were integrated so as to study various conditions that could exist if and when there are large scale energy development projects in that area. The Division participated in a similar study of the Yampa River basin wherein the data bank was used. The data bank was also used in recent drought studies. The staff of the Division uses it in performing various studies in support of legislated Division requirements.

Although the data bank is stored on the CSU computer, only the Division can have direct access to the Colorado Water Data Bank because of legislative and executive policy. The legislature has funded the data bank on both a general fund and cash fund basis and they expect the Division to generate funds from the Water Data Bank usage. The data that are stored in the data bank are public information and the data and reports are available for review in the Denver Office. You may come in and "look for free," but copies of reports will cost you money. It is difficult to say which part of the data bank is used more, but it is safe to say that water rights, diversion records, and well file information comprise the greatest part of all information requests.

The Colorado Water Data Bank is more than just a project of the Division of Water Resources in which the Division's technical records are being computerized. It is also a concept. That concept is a valid and successful attempt on the part of the Division to bring order and understanding to the raw data of those water resources of the State over which the State Engineer has administrative responsibility. The Division is trying to provide some of the answers to the State's water resources problems. The Colorado Water Data Bank is the beginning of an answer to one of the problems--accurate and meaningful water resource data.

THE TEXAS NATURAL RESOURCES INFORMATION SYSTEM

By John H. Wilson[1/]

We appreciate the opportunity to participate in this, the first NAWDEX membership meeting. I will briefly review the development and some of the operational activities of the Texas Natural Resources Information System (TNRIS). Several important areas of TNRIS involvement will be addressed including our interface with other systems in Federal Governmental agencies and other entities in the public and non-governmental sectors.

The Texas Natural Resources Information System (TNRIS) was established to serve as a mechanism within the State for linking together the users of natural resources and related data with those agencies and institutions which collect and store such data.

Development and operation of TNRIS is guided by a Task Force made up of representatives from 13 State agencies having responsibilities in the natural resources and environmental fields. In addition to supporting these agencies, TNRIS also provides support and services to other State agencies and to Federal, regional, and local governmental agencies, academic institutions, and private entities within the State.

In commenting on the history of TNRIS development, I should indicate that, first of all, it has been established around this particular principle: "One of our State's greatest assets is its natural resources, and one of our great challenges for tomorrow is the proper planning, developing, managing, and conservation of these resources."

TNRIS origins actually relate substantially to the "hydro-illogical cycle," the drought portion of which was manifested in Texas very severely in the early 1950's, followed by record floods.

Out of these events grew a need to coordinate some of the water-related activities in the State, and from that need came a statutory charge to the Texas Water Development Board to develop a hydrologic information system, incorporating the data from various State agencies. Establishment in the State of Texas of what was known as the Water Oriented Data Bank followed.

Some of the initial activities related to development of this Data Bank included the cataloging of water-related data in concert with the fine work that was being done by the U.S. Geological Survey's Office of Water Data Coordination. This cataloging activity included the inventorying of state-

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[1/] Manager, Texas Natural Resources Information System --Systems Central, Austin, Tex.

held water resource data. A group of eight State agencies worked on this particular effort and on other inventorying activities in the water field.

As the Water-Oriented Data Bank work grew, it was recognized that a broader, more comprehensive system was needed, and the concept of a Texas Natural Resources Information System was born. Data bank participation was expanded in 1972 to include 15 State agencies in a TNRIS Task Force. With the passage of legislation consolidating the State's three water agencies in September 1977, the number of participants was reduced to its current level of 13.

Many fundamentals of the TNRIS Conceptual Design were developed by the data bank agencies in the early 1970's, at about the same time the USGS was working on the NAWDEX design. As I proceed, it may become evident that many ideas implemented by TNRIS were first published in a 1971 Federal Interagency Advisory Committee on Water Data report on "Design Characteristics for a National System to Store, Retrieve and Disseminate Water Data."

In June 1972, at the American Water Resources Association's conference on "Watersheds in Transition," staff of the USGS Office of Water Data Coordination (OWDC) presented a paper entitled "NAWDEX--A System for Improving Accessibility to Water Data." Many ideas contained in the paper, including that of a "Systems Central" staff to coordinate the linkage among data contributors and data users have been adopted by TNRIS. We in Texas feel most fortunate that we were able to benefit from close coordination with the U.S. Geological Survey.

The basic need for TNRIS stems from these facts:

- Texas has multiple natural resource agencies

- These agencies have varied data requirements including:
  - Regulation,
  - Management,
  - Planning,
  - Development,
  - Conservation, and
  - Protection.

- Multiple data sources exist which serve these agency needs, and

- The costs of these data continue to increase.

We feel that one of the significant strengths of TNRIS is, in fact, the interagency coordination that is fostered among these agencies through joint development of the capability to serve common needs.

The experience within the State of Texas is--we believe--also probably significant as far as other States might be concerned. Texas may likely have one of the "worst case" situations for coordinating State-type activities. We have over 250 boards and commissions in the State government. There are more State employees in our highway department alone than many other State governments have in their total State employment. You see represented within the 13 natural resource agencies in excess of 40,000 State employees, with offices in approximately 500 different locations throughout the State.

So from a coordination standpoint, it is clear that Texas has come a long way in being able to coordinate the activities of the natural resources-related agencies within the State.

Some of the goals of TNRIS are:

- To facilitate State agency fulfillment of specific statutory responsibilities and administrative needs.

- To provide support to: planning, developing, operating, managing, conserving, and protecting State natural resources.

- To provide a multidisciplinary approach in addressing member agency statutory requirements and objectives,

- To provide maximum availability of data and information, and

- to reduce costs.

The primary goal, we feel, is the first one: the need for an information system was built around the desire to serve the member agencies, to facilitate the carrying out of their legislative mandates. TNRIS was not designed to take away control, nor was it designed to centralize everything.

The organizational concept of TNRIS is somewhat unique. It provides a linked network of user entities acquiring and maintaining natural resources data. TNRIS Systems Central provides a point of contact for information on data availability, procurement, and analysis. It is a centralized facility which provides storage, retrieval, processing, analysis, and presentation where appropriate of natural resource data and information. As previously stated, we have not tried to centralize everything but instead have sought to link together the information systems existing within the State to try to keep a good handle on what data is available in the State; then we provide a systems central staff to coordinate the activities of the System. There are presently 14 staff members that perform this function. We feel like this is one of the significant strengths of the System. For example, we have in the State of Texas a staff which can provide a point of contact for work with the U.S. Geological Survey's National Water Data Exchange, National Water Data Storage and Retrieval System, National Cartographic Information Center, and several other Federal Systems. The third element in the TNRIS organization is a centralized facility with a variety of computer resources including a UNIVAC 1100/41 computer, computer graphics capabilities, and microfilm capabilities.

The TNRIS can provide a wide range of services and products which can be called upon as needed for interfacing with the various Federal Systems from agencies such as the USGS, EPA, the Department of Commerce, including the National Oceanographic and Atmospheric Administration, and the Department of Agriculture.

The activities of the System itself are also very broad in scope.

They include:

- Indexing Sensed, Monitored, Measured, and Collected Data Existing in Both Machine Processable and Non-Machine Processable Form

- Storing Selected Data in a Systematic Manner as an Information Base

- Disseminating Data From the Information Base

- Referral of Inquiries to Other Data Sources

- Adjusting and Organizing Data Into Forms Suited to Storage, Retrieval, or Analysis, and

- Manipulating and Processing Data into Graphs, Models, Study Plans, Specifications, and Simulation Systems for Natural Resources Management.

In organizing the data files within TNRIS, the TNRIS Task Force has defined six categories of data. These include Meteorological, Water Socio-Economic, Biological, Geologic and Land, and Base Data Resources.

The broad scope of TNRIS activities is in itself a strong characteristic of the System. Of necessity, a wide variety of disciplines must be included among the personnel that are involved in TNRIS work.

TNRIS is also incorporating a wide variety of different data types. We have a great deal of machine-processable data. For example, there are in excess of 300 reels of magnetic tape in one particular file.

TNRIS does a lot of computer processing of data and also provides computer terminal access to various users. In this latter area, the System is providing computer terminal access to some of the regional and local governments. Such access is being provided to several of the State's river authorities and councils of government, and some Federal agencies utilize the system.

Also incorporated into the System are published and unpublished data. Currently in progress among TNRIS member agencies is an inventory of non-machine processable data files held by the agencies. The results of the inventory will be published as an update to the TNRIS File Description Report. In addition, TNRIS maintains a very close working relationship with the State libraries in Texas.

A wide variety of map-related data is incorporated into TNRIS, some of which is stored in computerized form for analysis by the System. Also included under the Base Data category, as one of our major efforts, are some remote sensing-related activities which involve regional aerial photography as well as some of the more recent satellite data.

TNRIS Remote Sensing Capabilities and Services Include:

- Indexing and cataloging of remotely sensed data, photo lab capabilities, and interpretation and acquisition capabilities within the State;

- Establishing imagery data files;

- Data retrieval in the form of imagery index maps and imagery browse files;

- Assistance to users in ordering data;

- Data analysis using satellite digital data and computer-assisted classification techniques; and

- Education and consultation ranging from remote sensing overview courses to image interpretation short courses.

TNRIS is using an extensive set of computer techniques to analyze remote sensing data, and we have several ongoing projects within the State with strong support from the NASA Johnson Space Center.

An ongoing educational program of TNRIS involves the major data users within the State, from State agencies, Federal agencies, local and regional government, as well as from the private sector, in educational offerings. Here again we feel like this is one of the strengths of the System. A variety of presentation methods and publications are involved and utilized in TNRIS educational programs. TNRIS has a Newsletter that is published and distributed to an extensive user community, in order to document TNRIS activities.

The users of TNRIS include:

- State Agencies
- Federal Agencies

- River Authorities
- Local/Regional Governments
- Colleges/Universities
- Nongovernmental Institutions/Businesses/Industries
- Private Citizens

Some of the ways in which they use the System are:

- Statewide Resources Planning
- Enforcement Functions
- Environmental Assessments
- Coastal Zone Management Activities
- Regional/Local Resources Planning
- Energy Conservation Activities
- Land Use Considerations

As far as state-level benefits are concerned, TNRIS provides a mechanism to

- Reduce duplication in data procurement, storage, processing and analysis; reduce duplication in computer hardware, software, and staff; and reduce costs through a coordinated interagency approach to natural resources information.

In addition, the TNRIS provides

- A single point of interface with other such systems at Federal and local level,
- More consistent data quality standards for higher reliability in final products, and
- A comprehensive information base which can respond to varied and complex requirements.

Three major activities of the TNRIS seem particularly appropriate to cover today. The first of these, computer analysis of remotely sensed data, was briefly mentioned earlier.

As you may be aware, in July 1972 NASA launched the first of three Earth Resources Technology Satellites, commonly called ERTS. ERTS, which was later renamed Landsat, provides multispectral sensing of the Earth's surface in four spectral bands, two in the visible spectrum and two in near-infrared bands. Each of the two remaining Landsat satellites completes a pass over the Earth once every 18 days.

A great deal of computer software has been developed for processing digital spectral data from the Landsat satellites. The TNRIS, with assistance from NASA, has been involved in using existing remote sensing software and developing new software to use the Landsat digital data in producing land cover and land use maps for the State of Texas. Several joint projects between the TNRIS and some of its member agencies have been initiated to test the utility of using Landsat data for these purposes.

TNRIS remote sensing staff also provide assistance to TNRIS users in locating and ordering remote sensing products such as aerial and satellite imagery. Several indexes of remotely sensed data are available through TNRIS Systems Central including the Soil Conservation Service's Texas aerial photography, the U.S. Corps of Engineers' coverage of the Texas Coast, the Agriculture Stabilization and Conservation Service data for Texas counties since 1941, and Federal photography available through the EROS Data Center.

Another area of TNRIS activities is that of computer processing of map-related data. TNRIS staff have been involved for several years in a project to develop a generalized Geographic Information System for storing and reproducing map-related data at various scales and projections.

Using the GIS, data can be extracted from cartographic products in the form of areas, lines, and points; stored on computer files, along with textual information associated with the data; and reproduced in the form of map overlays. Base information such as soil type locations, biologic assemblies, oil and gas wells, pipelines, highway locations, and dam locations have been stored in the GIS. Using the TNRIS Geographic Information System, map data extracted from several different base maps at any scale or projection can be combined in a single map.

The GIS makes use of the Texas Department of Water Resources' graphics hardware including digitizers, graphics terminals, and plotters--all handled by a minicomputer. Map-related data is converted to computer form by a digitizer which registers a series of points as the map features are traced by an operator. These points are connected to form line segments by computer software and are reproduced on either a plotter or a graphics terminal.

Several kinds of data have been processed through the GIS including soil type locations. Soils data provided by the Soil Conservation Service and mapped at 1:24,000 by staff of Texas A&M University was processed through the system. Color shaded plots at any scale in any of 8 different projections represent the final product.

A habitat map using General Land Office data in the Coastal Zone was produced as a further test of the system. In this map, habitats were identified by labels in addition to shading.

Point data such as oil, gas, and water well locations, and line data such as county boundaries, river basin boundaries, and roads can also be stored and reproduced by the Geographic Information System.

Systems Central staff has recently completed a project with the Texas Forest Service to map southern pine beetle infestations in East Texas. Color maps showing pine beetle infestations and the types of control applied to each were produced for use by the Forest Service in an effort to educate the public on the extent of the problem.

Map data can also be stored in computers in grid cell form. Normally a rectangular grid which represents a fixed area on the ground is chosen for recording data. The area in a single cell will generally vary depending on the type of data being recorded and on the geographic area to be covered. In a joint project with the State Office of the Soil Conservation Service, TNRIS has developed a Computer Based Mapping System (CBMS) for handling gridded data. The TNRIS/SCS joint project was established to map soils and land-use data for Texas counties.

Data are being recorded using 15.44 acre grids in the UTM coordinate system. CBMS was developed using a computer system called the Map Information Analysis and Display System (MIADS), developed by the U.S. Department of Agriculture.

The system can generate printer plots of soils and land-use data as well as produce interpretive maps. Examples of interpretive maps which have been generated include prime and unique farmland maps for Travis County.

The Computer Based Mapping System is also capable of producing reports which show the acreage covered by a particular soil in a county and the acreage of any soil related to a particular land use. These data can be used for broad-based planning in the State.

A third area of TNRIS involvement, which we consider vital to our goal of providing for maximum availability of data, is that of establishing interfaces with other systems in the public and private sectors. We have been very pleased by the results of our affiliations with such systems as NAWDEX, NCIC, WRSIC, and STORET.

As a NAWDEX (National Water Data Exchange) local assistance center, TNRIS Systems Central and the individual TNRIS member agencies are included in the NAWDEX Water Data Sources Directory. Details on several TNRIS files have been entered into the Master Water Data Index. TNRIS staff satisfied 554 requests for data and information during the quarter ending in February 1978. Of these, more than 100 were for data which TNRIS has indexed in NAWDEX.

The Water Resources Scientific Information Center (WRSIC) has provided a computer terminal and allowed free access by TNRIS to its automated Water Resources Abstracts data base. TNRIS Systems Central staff frequently search this and other available bibliographical files to satisfy their requests.

TNRIS access to the STORET (Storage and Retrieval) system for water quality data is provided by the Environmental Protection Agency. As a part of our Texas/EPA interface, data collected at 39 locations in Texas by the Texas Department of Water Resources is routinely entered into the STORET data base.

Many TNRIS data files are currently available through remote computer terminals using a computer system called the TNRIS Monitor. The Monitor is designed to be used by persons with little or no background in data processing. Currently underway is a project to allow Monitor users to automatically be connected to other automated data files. Thus, data from several different files on different computers will be available to TNRIS users in a single session on the TNRIS Monitor. This capability will significantly expand TNRIS user services since, for example, any present TNRIS remote terminal user will have immediate access to WATSTORE and the NAWDEX indexes.

In conclusion, I would like to reiterate that one of the major activities of the TNRIS is to provide primary natural resource and related data to the users of such data. Requests are accepted via telephone, letter, and walk-in to our offices.

Copies of an overview of the TNRIS and the Water Oriented Data Bank Systems Capabilities Manual have been provided for those who are interested. The address and telephone number of TNRIS Systems Central are contained in the overview. We will be happy to answer any questions about the TNRIS here or at our offices in Austin.

DESIGN AND DEVELOPMENT OF THE IOWA WATER RESOURCES DATA SYSTEM (IWARDS)

By Richard L. Talcott[1/]

INTRODUCTION

In 1974 the Iowa Natural Resources Council undertook an interagency project to develop a comprehensive water plan. A "task force on data base and needs" was led by the Iowa Geological Survey. This task force recommended that a system be established to improve accessibility of water-related data. To this end, an advisory committee was formed to guide the design and development of the Iowa Water Resources Data System.

Project Description

The Iowa Water Resources Data System (IWARDS) is an interagency project for improving the availability of data for water management, planning and research. Its interagency basis is an Advisory Committee (appointed by directors of participating agencies) that guides development and operation of the project by staff at Iowa Geological Survey.

IWARDS services, free of charge (or at nominal cost in some cases), are scheduled to be available before June 1978. Currently, certain aspects of IWARDS services are entering a demonstration phase, and system features will be presented to interested groups prior to the June 1978 implementation date.

IWARDS Services in Brief

IWARDS services if authorized for full implementation, will include:

Data Base Management Software

IWARDS will provide, and support on the State computer, Data Base Management Software (DBMS). Any State agency may use this software, to avoid the high cost of acquiring or developing their own. It will enable them to do a variety of data processing tasks, using simple, English-like commands, rather than having to write special programs.

Clearinghouse

IWARDS will provide reference services for Iowa's water data by maintaining a data index and bibliography, and will also serve as a National

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[1/] Manager, Iowa Water Resources Data System, Iowa Geological Survey, Iowa City, Iowa.

Water Data Exchange (NAWDEX) Local Assistance Center. IWARDS will assist in the retrieval of data for requesters and will store frequently-requested data on the state computer for direct access by participants. Priorities and procedures for data acquisition and exchange are to be set by the IWARDS Advisory Committee.

Systems Analysis

IWARDS will assist State agencies in evaluating the applicability of the DBMS for their data processing needs, in training of operators, and in performing transition tasks. IWARDS will also perform non-routine analysis and display processing for a nominal charge. This service will include statistical summaries, cross-tabulations; and graphic display from package programs available at the University Computer Center in Iowa City.

Research

In support of studies performed by State agencies, IWARDS will undertake investigations directly related to ADP techniques and information systems issues, in response to needs identified by the Advisory Committee.

These four categories of service each represent a type of need identified by the agencies participating in water plan activity. By developing one data service for a number of agencies, IWARDS enables a relatively cost-free upgrading of data management techniques, and encourages system compatibility that will ease data transfer. IWARDS is an information and reference service, rather than a data bank, per se. Emphasis is on increasing the accessibility of data, although IWARDS will maintain data files when doing so is more efficient than referring requesters to existing sources. IWARDS service is guided by the Advisory Committe. This committee establishes data transfer priorities and procedures, and recommends data conventions, for example, for locational referencing, quality control and documentation.

Initial Research

A survey was conducted of water data management in all 50 States. Then, a follow-up survey was sent to States whose responses to the first questionnaire indicated experience relevant to IWARDS development. Focus in these surveys was on information about Data Base Management Systems that might be acquired or emulated by IWARDS. Following evaluation of the surveys, site visits were made to the Louisiana Environmental Management System, and to the "OMNIANA" system in New Mexico. In addition to surveying water-related systems, research was done on generalized data base management systems and practices, and on strategies for design, development and implementation of geographic information systems.

Systems Management also surveyed agencies represented by the Advisory Committee to determine what services and processing capabilities were most needed to improve efficiency and effectiveness in data management. Based on this survey the staff wrote narrative descriptions of agency data handling. Also, examples of specific tasks needing IWARDS support were written to form a basis for appraisal of potential IWARDS benefits. These narratives and task examples are incorporated in the present report.

System Development Decisions

The Advisory Committee approved a Systems Management proposal to develop, rather than acquire, the software for data base management; and adopted a procedure for making design and development decisions. Other major tasks performed by the Advisory Committee during the system development phase included defining the scope of IWARDS services and setting guidelines for procedures and policies of IWARDS operation. The continuing involvement by the Advisory Committee, as a working team, is evidenced by this design report, which in essence, reports on the results of deliberations by this group.

GOALS AND OBJECTIVES

IWARDS goals and objectives were formulated in recognition of the water planning context, and of the scope and direction foreseen for the project by the Task Force on Data Base and Needs. The statement of goals and objectives adopted by the Advisory Committee reads as follows:

> "Increasing demands on natural resources in recent years have brought an acute awareness of the need for rational resource management programs. Resource shortages can have disastrous effects on the state, national and international economy, and can result in an unstable political environment and serious degradation of the quality of life. This is especially true of water. As industrial, municipal, and agricultural uses of water increase, and as Iowans in ever-growing numbers seek out water-based recreation opportunities, care must be taken to see that this resource is managed and used wisely so that adequate supplies of good quality water will always be available. Rational management of Iowa's water supply is the goal of the State Water Plan, now being developed by the Iowa Natural Resources Council with input from a consortium of other agencies and organizations.
>
> "Wise planning requires information to support the decision-making processes. Baseline information concerning the distribution of, variability in quantity and quality of, and demand for water in Iowa is being incorporated in the Framework Study which is now in preparation. However, the need for information is ongoing. Continually updated information is necessary to monitor the effects decisions have on the supply or quality of water. Making available the best data for continual study of the water cycle is essential to increase our understanding of the movement of water in the environment. To serve these purposes, the Iowa Water Resources Data System

(IWARDS) is being developed. The goal of this system is to support comprehensive water planning and management in Iowa, by improving the availability and usefulness of water resource and related data.

"An information system can support the water planning and management effort in several ways:

-- Monitoring ongoing conditions to detect infraction of regulations;

-- Monitoring local conditions to determine the effects of management decisions on the quality or availability of water;

-- Assessing local conditions to predict or model the effect of changes (new withdrawals, effluents, etc.) on water availability or quality.

-- Research, to provide a better understanding of the hydrosphere and man's relationship to it; and

-- Other activities which may affect the quality and quantity of water available in Iowa.

Primary information systems are already in existence in various agencies and institutions to support these functions. IWARDS is not intended to supplant these existing systems, but to supplement them and enhance their usefulness by improving interagency data communication. Ultimately, it may be in the interest of each agency to use IWARDS software to handle their in-house data but this decision can only be made after careful study of agency needs.

"There are many kinds of information needs related to water management and development. While a major contribution by IWARDS will be the development of a computerized storage-retrieval system, its scope is not limited to that activity alone. Specific objectives that reflect the broader purview of IWARDS are to:

1. Develop a management structure within which development and operation may proceed in the most cost-efficient manner;

2. Encourage interagency and State-Federal cooperation in the use of water data by providing a vehicle for the interagency exchange of data, and access to water data in Federal data systems;

3. Design and implement a computerized data storage and retrieval system;

4. Study and identify the data needs of State agencies involved in water related activities;

5. Inventory available machine-readable data supplies held by State and Federal agencies;

6. Specify and document a design for the system, including the establishment of procedures for input, update, retrieval, and distribution of data;

7. Determine hardware needs for a successful system and acquire needed hardware;

8. Provide assistance to potential users in identifying their requirements and estimating their expenses if they wish to use the system;

9. Acquire or produce software to support the operation of the system;

10. Document the software in order to make the system easy for all to use;

11. Acquire data for storage in the system;

12. Publish indices of data included in the system for the benefit of data users;

13. Continue development of the system after its implementation, by the addition of advanced processing capabilities.

14. Develop standards for geographic and site identifiers and coding of data for computer storage and processing;

15. Identify, and eliminate where possible, unnecessary duplication in the collection, storage, and processing of data;

16. Compile and publish certain types of water-related information which are not suitable for inclusion in the computerized storage-retrieval system, specifically: a bibliography of water-related data pertaining to Iowa; a directory of State and Federal agencies with responsibilities relating to water resources in Iowa; a summary of Iowa's water laws and regulations; and an index of water-related data held in the files of State and Federal agencies."

ORGANIZATION

Basic components of IWARDS organization are Systems Management, the Advisory Committee, and the community of Data Users/Generators.

Systems Management is the staff component of IWARDS. Supported by the Iowa Geological Survey, it receives guidance from the Advisory Committee on priorities for allocation of its services. Systems Management also assists the Committee by providing background information for policy and procedure decisions. Personnel matters affecting Systems Management are the responsibility of the Iowa Geological Survey.

Specific Responsibilities of the Advisory Committee

In outline, the responsibilities of the Advisory Committee include:

1. Guiding IWARDS design, development, implementation and operation.

2. Reviewing needs and setting priorities for obtaining (access to) data, and for storing data in a data bank;

3. Recommending conventions for data coding definitions, documentation, and quality control;

4. Cooperating in and coordinating data collection and exchange;

5. Communicating data management needs of their respective agencies that might be served by IWARDS; and

6. Identifying and recommending new or revised procedures for collecting and transferring data.

Advisory Committee Decisionmaking Procedure

Throughout the design and development of IWARDS, the Advisory Committee has provided input regarding data management needs, the appropriate mechanisms for serving those needs, and the procedures and arrangements for effective and efficient operation. A concensus-seeking procedure has been implemented for identifying various issues or questions, and resolving them. The procedure is structured similarly to a planning technique called "Delphi", but is less formalized. It provides adequate opportunity for members to express their view; to examine the views of others, and then if desired, modify their initial positions. The systems management staff acts as a "courier" of information among members prior to their addressing the question in a group.

BASIC CONCEPTS

What Does the Data Base Management Software Do? How Does it Work?

The manipulation of data by computer is accomplished through use of instructions in some language -- FORTRAN, COBOL, ALGOL, etc. These instructions are compiled into a set of basic, arithmetic steps that are performed by the computer. Higher-level languages use English-like instructions; and highest level languages are not altogether different from simple commands, like "Read the ABC file," and "Write the ABC file for cases without brass widgets." The IWARDS DBMS is a "highest" level language. It uses simple commands to perform rather complicated sets of machine operations. The use of the DBMS language can eliminate the need to write special programs each time there is a need for different selections or computations of data -- and, the DBMS is well suited for doing specialized data searches and retrievals.

Features of the DBMS

The system is modular, with higher-level subroutines performing system control tasks and lower-level subroutines performing specific file and record processing. The data structure is hierarchical and uses variable length records. The DBMS will make efficient use of available space. IWARDS files can be created from user-defined input or can be derived from other available files. The format of the data stored need not be known to the user but the characteristics of a hierarchically structured file need to be understood to use the system most effectively.

File and Record Security Measures

To maintain the security of data within the system, files can be protected from unauthorized access by using passwords. Users can create and update their own files with password protection and have complete control over the storage and retrieval of data in their own files. They can also use password protection on specific records in their files so that portions of the file can be accessed by other users with permission, but protected information cannot. This allows the user a great deal of flexibility in sharing his data with other users. He can make all of his data available to users or he can make none of it available, or he can protect certain records from unauthorized access.

The Command Language

Data Base Management commands are of three types, including:

A. File Commands, such as

SIGNON - "starts" the system,
CREATE - allocates space for and creates an IWARDS file,
DELETE - deletes an IWARDS file and frees storage space,
TRACE - prints diagnostics with output,
SETUP - informs the system of the characteristics of external files to be processed,
LOAD - loads a "dictionary" for a newly created file,
SORT - sorts a file or subfile into a specified sequence,

DEFINE - creates and stores a new macro command for later use.
UPDATE - initiates a sequence of actions, to add, change, or delete data items within existing records, or delete complete records,
EXECUTE - initiates execution of a preceding sequence of record commands; and

B. Record commands, which operate on individual records or the data items within them, including

INPUT - inputs one record of data from an external file,
READ - makes a record of IWARDS data available for processing,
FIND - searches the hierarchy file for a particular record or set of records and makes the record available for processing,
REPEAT - used with INPUT, READ, or FIND generates control code enabling the entire file or some subset to be made available for processing.
TABULATE - uses data made available by the above-mentioned commands to generate tables of the contents of records,
LIST - uses retrieved data to generate lists of the contents of records,
TAPE - generates fixed format output to external tape or disc files,
PUNCH - generates fixed format output to a punched card file,
OUTPUT - generates IWARDS records and hierarchy descriptors for output to an IWARDS file (on disc),
LET - introduces an arithmetic expression,
IF, THEN, ELSE, and END - test a specified condition, and generate actions based on the results of that test;
PERFORM - executes a subroutine provided by the user. This command enables the user to provide his own programs for functions which are not handled by the supplied DBMS software; and

C. Sequences of file and record formats that may be stored on disc and invoked by the use of a single "Macro" command. These sequences may be defined for some routine function, such as producing a periodic report.

Implementation of the DBMS in the State Computer

The DBMS will be implemented on the State computer, and is available for use by any State agency that wishes to do so. IWARDS Systems Management provides free training and assistance in the use of the system. Although designed primarily for use in water plan activity, the system is well suited for any application in which search, selective retrieval, and computation on raw data are frequently required. Repetitive, report-generating tasks can be performed more economically by special purpose programs; however, non-routine tasks seldom justify the expense of special programs. Examples of appropriate uses for the DBMS are presented below in this report; and the second volume of the Data Catalog is devoted to documentation of the system.

What is the IWARDS Data Bank?

Although IWARDS is primarily an information resource and data access service, there will be some data in sufficient demand by more than one user, so that easiest access would be from a centrally maintained data base on the Comptroller Data Processing (CDP) Computer. These will be free-access read only files that may be used by anyone with access to the CDP computer without prior arrangement being made with the data generator. The files are to be selected by the Advisory Committee. Every effort will be made to format the files, standardize parameters, assure quality control, and provide adequate documentation, to make these files widely applicable. Users can selectively retrieve data from the files and process the data to fit their needs. Because the Advisory Committee oversees selection, coding, quality control measures and documentation, the cost of storage will be balanced against the benefits of rapid success, in deciding what data will be entered into the Data Bank.

Contribution of Data to the Data Bank

Contribution to the Data Bank is strictly voluntary. Agencies are encouraged to supply documentation and follow standard data specifications recommended by the Advisory Committee. System monitoring by IWARDS staff will enable new data sets to be catalogued soon after they are entered. IWARDS staff will assist as needed, to prepare files for the data bank. The standard procedure for creating new data bank files will be for the contributing agency to request IWARDS staff assistance; for the agency to follow advice of IWARDS staff as regards documentation and data transformations; and for the agency to follow through with necessary encoding and file processing. The new data set will then be added to the IWARDS data catalog, along with appropriate documentation. Data Bank files are then available, without restriction, to members of the participating agency group. "Non-standard" procedures will be possible and are to be developed through consultation with the Advisory Committee.

How Will Clients be Informed of Available Data?

Systems Management, in performing as a data Clearinghouse, will maintain indexes to data by type; by location, period of time or collection; and by source. Printed computerized and manual records of data documentation will be used for reference in assisting clients to locate data. Current programs of routine data collections are reported in another section of this Data Catalog. Other, special purpose data sets created in a research or special study context, will be catalogued by Systems Management as a part of the Clearinghouse function. Incidental publications by IWARDS will help keep potential users advised, though the principal means for obtaining information will be by direct inquiry to Systems Management.

How Will Data Be Collected and Coded for IWARDS? Who Decides What Data are to be Included?

Most data to be handled through IWARDS are currently collected and maintained by line agencies. When a need is established for collection of new data, the end users will cooperate to arrange data collection and processing. The IWARDS staff is not configured for data collection; its primary focus is on assisting in the management of existing data, and on maximizing the utility of that data. Depending on the type of data considered in new collection programs, there are several agencies whose expertise and experience recommend themselves as data collectors. IWARDS would not appropriately supplant the functions of these agencies.

Data Encoding Issues

Data coding issues dominate the problem of interagency data sharing. Coding may be the most costly processing step when quality control is adequately maintained; and it certainly is the step for which potential data "sharers" express the most apprehension or lack of confidence. Systems Management, though not presently staffed to undertake a data coding program, has cooperated with the U.S. Geological Survey in a data coding project for water well strip log data and water quality analyses. This coding project may serve as a model for coding procedures in other cooperative programs.

Alternative Solutions to the Coding Cost Problem

When a data generator is unable to perform coding for IWARDS, there are alternatives that would share coding costs among data users. These alternatives may be far less costly to users than would be a separate effort. Options include:

1. Coding of acquired data by the user;

2. User-contributed resources for coding by the data generator;

3. A jointly sponsored but centrally managed (by the IWARDS group of agencies) project that provides data coding to all;

4. Provision for coding costs in externally funded research or analysis projects;

5. Voluntarily increased work load for current data coding activity in one or more agencies to assist other agencies in data coding.

The Advisory Committee will consider these in seeking suitable arrangements for coding the data they identify as needed for water plan-related activity.

What Data Will be "Banked"?

All IWARDS data are not placed in the Data Bank. The Advisory Committee will select data that are frequently needed by more than one user, for inclusion in the Data Bank. In every case, the least cumbersome and most efficient method will be followed. In many instances, IWARDS' only function will be as a locator of data for a user, who will then obtain the data on his own. In some cases IWARDS will process data from some source and have it printed at the client's terminal.

How Will Data Standardization and Quality be Provided For?

Data Standards

Use of data combined from different sources is inhibited by differences in locational referencing, definition, frequency of collection, etc. The objective of standardization is to generalize the usefulness of data, and to make different data series compatible. There are two approaches to data standardization: One is to establish conventions and urge the data community to adopt them; and the other is to transform data, using special purpose conversion programs. Either or both may be used, but standards should be established nonetheless.

The National Bureau of Standards is delineating procedures for developing standards for information management. Standardized water quality analysis procedures are being instituted by the U.S. Department of the Interior, in cooperation with a number of federal agencies. These are just two of many sources for guidance that will be tapped by Systems Management to provide information for decisions by the Advisory Committee regarding data conventions and data quality control. Based on background reports and recommendations by Systems Management, the Advisory Committee will take positions on the issues.

Data Documentation

Data Documentation, according to conventions approved by the Advisory Committee, is a part of the information to be maintained by IWARDS Systems Management in connection with its Clearinghouse function. This documentation will clearly and fully describe each data file, its contents, formats, quality control methods, data source, collection procedures, and any other information bearing on a decision to use the data.

Sensitive Data

As indicated in connection with the software description, password protection is provided within the IWARDS system. Additional discretionary measures are available. Agencies concerned about the sensitivity or confidentiality of data may confer with IWARDS staff on processing techniques to produce maximum usable information with minimum risks. A variety of data processing techniques of a relatively rudimentary nature, such as aggregation, statistical summarization, identification stripping, partial deletion, etc., are available for the protection of privacy and to avoid violations of confidence. Resolution of these concerns is feasible without suppressing information needed for the planning processes. This has been demonstrated in other contexts, e.g., by Census Public Use Sample data.

Data Quality Control

Information derived from analysis of raw data can be misleading for a number of reasons, including: inadequate sample size or biased sample; measurement error, coding error, or obsolete data; and specification error, or inappropriate analytical methods. It will be the responsibility of the data generator to document files according to generally acceptable criteria so that data users may evaluate data as to suitability for their intended use. Documentation does not mean the same thing as certification that data is accurate. Rather it means assessing and reporting on the reliability of the data, usually by statistical means. To the extent possible, statistical measures of data quality should be employed; and sources and collection procedures should be identified. Systems Management, in cooperation with participating agencies and the Advisory Committee, will set criteria for evaluating data quality. It may be found that two agencies (or more) could use data if it were collected in a different manner or if it were more accurate than necessary for the purposes of the data generator. The Advisory Committee will review "status and needs" reports by IWARDS staff, and strongly encourage joint responsibility among agencies collecting similar data.

How are Data Transferred among Users/Generators?

Passing data between Data Users/Generators is termed "query-response". A "query-response mode" is the means by which data are requested and received. A number of alternative query-response modes are available, depending on the source and form of requested data, and on the inquirer's needs and facilities for processing.

Alternative Query-Response Modes

All modes have in common the feature of being initiated through direct inquiry to Systems Management. Through this contact, the best feasible method is devised for transferring appropriate data. Among typical alternatives:

a. A request for data maintained in machine readable form at the national level is fulfilled by Systems Management. The data to be transferred are written out on the IWARDS tape device while the batch terminal in Iowa City is linked to the Department of the Interior (NAWDEX, WATSTORE) computer in Reston, Virginia. The data tape is then output to the inquirer's terminal or to disc storage through a link with the Comptroller Data Processing (CDP) Computer at Des Moines. (See figure 1).

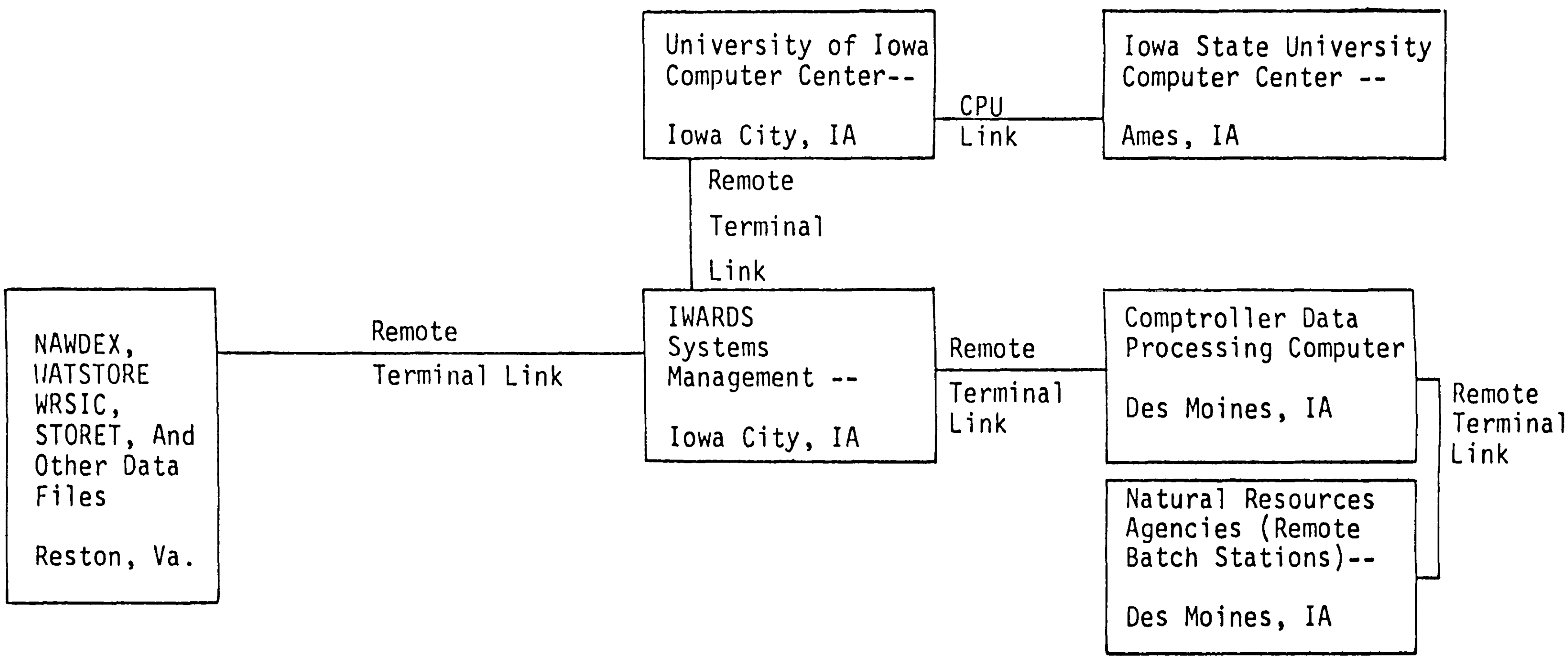

Figure 1. — Linkages Among Data Files.

b. A request is received for data in the IWARDS Data Bank. Systems Management provides the inquirer with necessary documentation to enable direct access to the data from the inquirer's remote batch station, using the IWARDS DBMS command language.

c. A request is received for data existing as a card data set at a research institution. The institution is asked to read the data to a temporary disc file where it can be read remotely from Iowa City. IWARDS Systems Management processes the data set as needed, and then makes it available on the CDP computer.

d. Data currently maintained only in manual form are requested. An arrangement is sought whereby the data can be encoded for machine processing, if it is determined that doing so would contribute towards IWARDS goals. If not, the inquirer is provided with printed copies of the data.

e. Data are requested that exists in the files of a State agency; however, only a subset of that agency's file is needed. IWARDS requests the agency to selectively retrieve its data and generate a new file that can be read by the requestor.

These of course are only hypothetical, illustrative query-response modes. IWARDS will strive for complete flexibility to match user needs with data resources and access methods. With the exception of data contributed to the Data Bank for unrestricted access, no data will be exchanged without the permission of the contributor. In no case is there any means for a user to access data without the permission and assistance of the contributor. Systems Management is unable to access data except when permission is granted. In other words, IWARDS does not take control of the data, it assists in data management. Control remains entirely with data proprietors.

What Authority does IWARDS Have?

Authorization for IWARDS Development

The Technical Coordinating Committee for the Water Framework study, and the Interagency Resources Council both approved the IWARDS development proposal, as presented by the Iowa Geological Survey. Thus, the development of IWARDS has had authorization by those responsible for the water plan, and may be regarded as a partial fulfillment of the mandate by the legislature to the water framework study group. Beyond July 1978, the prospects for IWARDS implementation are contingent upon a renewed commitment by policymakers.

Interagency Support

Because IWARDS is not a stand-alone project, it depends on a concerted interagency expression of support. It is imperative that Systems Management and the Advisory Committee bring the concepts and benefits of the project to the attention of agency decisionmakers. At appropriate times, well-documented presentations should be made before the Interagency Resources Council, demonstrating applications of the system. In turn, endorsement of IWARDS by the interagency group must be communicated to policymakers in the executive branch and legislature.

How Can IWARDS Reduce Duplication of Effort and Data Base Gaps?

Inventory of Data Collection Programs

With its Clearinghouse function, IWARDS will maintain a reference file on data collection by government, planning, and research organizations. Besides providing reference materials for those seeking data, this fill will enable assessment of duplication and omission of needed data. Frequent interaction with technical staff among the data community will enable a continuing update of this reference file.

Relationship to Other Data Exchanges

IWARDS is by no means the only data service available to Iowa, even in the area of water data. A number of agencies, especially through federal programs, are expanding their data bases and seeking ways to facilitate exchange. Of special importance among these are the U.S. Geological Survey, with its National Water Data Exchange (NAWDEX); the Environmental Protection Agency and its Storage and Retrieval (STORET) system; and the National Weather Service, which creates machine-readable precipitation data files. As an affirmative move to avoid paralleled effort, IWARDS has become a Local Assistance Center for the NAWDEX program, and cooperates closely with the Iowa City District Office of the U.S. Geological Survey in this connection. The principal, unduplicated function of IWARDS is to know where the data are and how best to retrieve data.

Generalized Applicability of System Software

The IWARDS DBMS is a general system that can be used effectively and with ease for a wide variety of data management tasks. Implementation of this software on the State computer makes it available at no cost to all State agencies. Training and assistance are to be provided by IWARDS, also at no cost. The IWARDS staff will engage in extensive outreach efforts to make all potential users aware of possible benefits to them. IWARDS conducted surveys before deciding to create this software, and found that appropriate capabilities were either unavailable or far too expensive, among candidate systems for acquisition.

COST OF IWARDS SERVICES

Charges to Users

Users of the IWARDS DBMS for their data processing will pay the usual machine costs. There are no charges by IWARDS for use of the software or for Clearinghouse or other services. In some cases, for example bibliography searches through the Water Resources Scientific Information Center (WRSIC), charges reflecting computer costs are passed to the information requester. In cases where IWARDS consulting or data analysis services are beyond the scope of routine services, cost sharing agreements will be made beforehand. Letters of agreement will specify work to be done and the requesters' cost for that work, in such instances.

Cost Considerations for Expanded Services

IWARDS staff are prepared to expand their scope of services to include geographic data processing, computer-based map data retrieval and display, and spatial analysis. However, certain hardware acquisitions would be necessary for initiation of an expanded operation. Major equipment items would include digitizing and plotting devices and ancillary equipment. Because of rapidly changing technology and cost factors, specifications for this expansion step have not been formulated at this time. Some preliminary research, development and demonstration work in this area has already been completed for the State of Iowa, particularly through university research. IWARDS would also draw upon literature generated by other tates' experience in this area, in order to provide cost-effective services.

DATA PROCESSING AND DATA MANAGEMENT NEEDS

Iowa's natural resources agencies use data for a variety of purposes. Traditionally, data is primarily used for record keeping -- storing and recalling "observations" of "cases" without extensive reference or comparison to other observations. Monitoring, on the other hand, requires comparison of observations with standards and/or previous observations at the same site. Planning entails trend projections, impact assessment, suitability studies and evaluation of alternative policies and programs. This activity places the most stringent requirements on data management. The emerging task of water resource planning has spurred interest by Iowa's agencies in improving the quantity, quality, and accessibility of machine-readable data. At the same time, increased workload and greater demand for information have placed a burden on agency recordkeeping and monitoring as well. The description given below is intended to illustrate some present needs and to indicate how IWARDS can help achieve greater efficiency and effectiveness. This description should not be regarded as a comprehensive report on agency activity. It is presented to illustrate specific benefits of IWARDS software and services.

APPLICATION EXAMPLE: IOWA GEOLOGICAL SURVEY

As might be expected (because it is primarily an information-oriented, rather than regulatory agency), the Survey's data handling tasks lean more heavily towards the planning than towards the recordkeeping category. Yet, because of its long history, the preponderance of data archived by the Survey is currently in printed or handwritten form. However, the Survey is cooperating with the U.S. Geological Survey to place geologic and water-quality data on computer files. Data from these files are frequently requested by well drillers, petroleum engineers, and others, for site selection, facility planning, exploration, impact analysis, etc. Several special-purpose computer programs are used to display information form these files of geologic and water-quality data. These programs print tables showing all the information on record for each county.

Aquifer Water Quality

A recent task connected with water planning makes a good example of the need for a more general-purpose, user-oriented program to selectively retrieve and display information from the files, in any desired manner. In support of the water plan framework study a map was constructed that shows how water quality in the Silurian-Devonian aquifers varies in different areas of the state underlain by these aquifers. Even though the data are encoded for computer processing, it was necessary to include a number of manual steps:

1. Modify an existing program to search the geologic file for wells having Silurian-Devonian aquifers as their only water source, to produce punched cards listing the identifiers of selected wells.

2. Manually inspect written records (strip logs) for the selected wells, to eliminate those that were incorrectly selected by the computer program.

3. Modify another program to compare the selected wells with those listed in the water quality file. This program will print a table of water quality indicators for the selected wells.

4. Draw in the data values, on individual maps, for each water quality parameter. These are "point data" maps.

5. Draw data value "contours" on the maps by hand, to show regional trends in values of each parameter.

Since the manual steps are involved, and programs have to be modified, the advantages of computer processing are not fully realized.

The IWARDS DBMS will enable most of the manual steps to be performed by computer. The general nature of the DBMS allows "program" modifications by simple commands, as well. Judgmental aspects of the task are not replaced by the DBMS. In other words, the computer processing can be done by a researcher with minimal computer experience but the analysis task cannot be done by a computer programmer with minimal research experience.

Using the DBMS, step 1 might be achieved with the following sequence of commands:

```
SETUP (WELLFILE, IWARDS)
CREATE TEMPFILE...
READ GEO NODE FROM WELLFILE
IF (BRKTOP .EQ. 'SILURIAN' .OR. BRKTOP .EQ.
'DEVONIAN') .AND. DEPTH .GT. FPBRK .AND. DEPTH .LT. DTOP
(ORDOVIC) THEN OUTPUT (ALL.WELL) TO TEMPFILE AS WELL NODE
     TABULATE (as desired) ONTO PRINTER
     READ QW NODE FROM WELLFILE
     OUTPUT (ALL. QW) TO TEMPFILE AS QW NODE
     REPEAT FOR QW NODE
     END
REPEAT FOR GEO
REPEAT FOR WELL
EXECUTE
```

This sequence creates a subfile containing records of wells that satisfy the specified condition. It also prints out a table of these wells, with other information as desired. Step 2 should still be performed manually to assure that the proper well records were selected. (For instance some wells have other sources in addition to the primary aquifer.) The table produced by Step 1 can be used to identify the wells which are judged to draw water from more than one source, and these records may be deleted from TEMPFILE by using the UPDATE command. Step 3 is satisfied by the printout produced in Step 1. Step 4 (plots of all the data left in TEMPFILE) may be produced with the following sequence:

```
SETUP (TEMPFILE, IWARDS)
READ WELL NODE FROM TEMPFILE
READ QW NODE FROM TEMPFILE
PLOT (SO4, HARDNESS), (NO3), (DISSOLID)
REPEAT FOR QW
REPEAT FOR WELL
EXECUTE
```

These commands produce maps indicating the raw data values. This laborious part of producing "point data" maps, is done entirely by computer. The drawing of contour lines is still done manually, in Step 5, although this may be done by computer in cases where rough approximations are acceptable.

In summary, the above procedures utilize the IWARDS DBMS to select records of wells which draw water from the Silurian and Devonian aquifers. This set is further reduced by review of those selected by the system using a computer-generated table and the UPDATE command. Since the geologic data and the ground-water quality data used for selecting the wells desired are in the same file, no match-up step is required when using the DBMS. (This merging is done when the files are created). Using the graphics capabilities of the system, maps of the raw data are produced directly by the computer and these are used to produce contour maps showing the values of the various water quality parameters.

Well Predictions

Well predictions address many points in addition to reviewing ground-water availability and quality, for example,

selecting test drilling locations;
proper spacing, to reduce well interference;
well construction recommendations;
well development techniques;
solutions to well contamination problems;
well abandonment and plugging advice;
water quality from the various aquifers;
the potentiometric surface of aquifers;
likelihood of interchange of water between aquifers;
ground water flow direction;
pumping test extrapolations of the radius of influence;
and others.

Frequently it is useful to make a prediction of the geologic section at the well site.

Several different sources of information are searched in order to compile a well prediction, for example,

ground water files,
bedrock and geologic structure maps,
well logs, and others.

It is a time-consuming task to search separate files and compile information. Because most of the files are also used by other analysts, there are sometimes missing or misfiled items. To the extent that the files are machine readable, much preliminary searching can be done by computer. The IWARDS Data Base Management Software (DBMS) will select the desired data items from several different sources and produce a summary table. From the summary table and from other information, the analyst can determine what information is needed to fulfill the well prediction request. He can then compose a narrative report. The machine-readable data can be used for computer-generated supplementary information. For instance, the geologic section could be computer drawn at low cost and included in the report.

Suitability Analysis

Frequently the Iowa Geological Survey (IGS) receives requests to provide geologic and hydrologic information for feasibility studies and/or environmental impact statements associated with proposed projects. As in the previous example, the source of most of the information is the strip log file. As an example, IGS might be asked to prepare information for application in planning the construction of a cross-country pipeline and assessment of environmental impacts:

1. The route is plotted on a base map that shows legal boundaries.

2. The location coordinates for sections of land traversed by the pipeline are recorded.

3. The strip log file is then researched for all wells of record that are closely adjacent to the proposed route.

4. Geologic cross-section diagrams are prepared along the route and notes are made concerning hydrologic circumstances.

5. A report is generated discussing geologic and hydrologic conditions and implications along construction route.

With an adequate system with digitized inputs and plotting capability, steps 1-4 could be mechanically performed with the savings of considerable time. Because the IGS data base contains locational references for each sample site, machine processing is feasible. Appropriate data are retrieved from the data base by the IWARDS DBMS, and a computer plotting program is utilized to create working maps. Other graphic routines may be adpated for assisting in display of geologic cross sections for specified geographic areas.

IMPLEMENTATION

Development and Implementation Strategy

IWARDS implementation is staged as a strategy for maximizing the communication of demand and response between designers, administrators and users of the system. Alternative strategies would have been to (a) design a full system, then train users; or (b) focus entirely on the specific individual needs of users, and develop system elements a piece at a time. The "staged" strategy is a middle-of-the-road approach. Consequently, certain capabilities of the IWARDS project are being demonstrated at the present time, along with user consultation. Other capabilities will be introduced gradually, and full services are scheduled to be available by June 1978.

Allocation of Staff Time to Implementation Tasks

The implementation schedule provides for staff support to Committee decisionmaking. Some issues are treated on a continuing basis, for example, "Data Collection and Transfer Needs." In other cases, such as "Data Coding Conventions," the Advisory Committee decisionmaking procedure will be followed, and recommendations will be issued by the Committee. Some services to be performed by Systems Management are unspecified at this time; these are to be identified by the Advisory Committee in connection with their evaluation of "Data Collection and Transfer Needs."

Current State of Progress

The design phase is essentially complete at this time (March 1978); design of software, and basic policy and procedural concepts have also been generally completed. Current activity is focused on completion of software and on selecting priorities and specific arrangements for implementation of services. Implementation of the project includes the major task of completing a data directory and a data source directory. As indicated earlier, the guidance of the Advisory Committee will be relied upon in establishing appropriate conventions for documentation of data.

DATA NEEDS FOR STORMWATER MODELING, TREATMENT AND CONTROL

By Miguel A. Medina, Jr.[1/]

INTRODUCTION

The first Engineering Foundation conference on urban hydrology in 1965, cosponsored by the American Society of Civil Engineers' Council on Urban Water Resources Research, revealed a nationwide lack of basic information on sewered catchment dynamics. A serious need for field data on rainfall-runoff-quality was clearly identified, yet almost a decade later not much new data had been acquired on these catchments using flumes or weirs rather than stage gages for determining discharge from urban runoff (McPherson, 1974). Only recent funding of Public Law 92-500, Section 208, metropolitan water quality planning studies, has resulted in major data-gathering efforts on the quantity and quality aspects of urban runoff.

The dynamic processes that govern the movement of a body of water involve the transport of energy, mass, and momentum by conduction (diffusion), convection (advection), and radiation. These transport processes are readily expressed mathematically through rate equations, or differential equations as they are better known, since the amounts transferred are directly proportional to the gradient existing in the fluid medium. Mathematical modeling of hydrologic processes has developed rapidly in the last two decades through the use of numerical solution techniques and high-speed digital computers. Continuous simulation allows the analyst to estimate the probability of occurrence of events of various magnitudes (Linsley and Crawford, 1974), which has essentially rendered the single "design storm" concept obsolete in the decisionmaking process. Hydrologists and meteorologists have until recently concentrated their efforts largely upon the determination of *quantity* of water in each of its physical phases as it passes through the different stages of the hydrologic cycle.

Conversely, environmental engineers and scientists have placed great emphasis within the last decade on assessing the *quality* of our receiving waters (streams, lakes, oceans) as characterized by a rather diverse number of *physical*, *chemical*, and *biological* indicators, or *water quality parameters*. More often than not, experience suggests the water quality parameters to be measured in determining the degree of acceptability of a body of water for a specific intended use. The strength or concentration exhibited by each of the chosen parameters provides a means of comparison with approved *standards*. Standards usually express the allowable maximum concentration of a pollutant or the minimum allowable concentration of an essential element for living systems, such as dissolved oxygen. A great deal of controversy surrounds the setting of standards in terms of both numerical value and intended

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goals, and a discussion of this topic is beyond the scope of this paper. A high degree of sophistication has been reached in instrumental methods of analysis and we are now able to characterize precisely a water or wastewater in terms of most physical and chemical parameters. Biological indicators are another matter; reproducibility of results is extremely difficult, if not nearly impossible in some cases.

We are reasonably capable of predicting transient water quality *within the boundaries of the receiving waters*. However, such predictions are necessarily dependent on meaningful quantification of surface runoff from accurate rainfall data, verification of pollutant washoff rates from various land uses, and existing records of receiving water quality prior to each storm event. The task of modeling water quality changes within the hydrologic cycle is a formidable one and will require close interdisciplinary and interagency cooperation. The U.S. Geological Survey collects, analyzes, processes, stores, retrieves and publishes enormous volumes of water-quality related data annually. Chemical, physical, biological and radiochemical parameters for both surface and ground waters are encoded for inclusion in the Survey's National Water Data Storage and Retrieval System (WATSTORE). A control program also provides an interface for the transmittal of such data into and from the U.S. Environmental Protection Agency's Storage and Retrieval (STORET) information system (Edwards, 1974). Users of continuous hydrologic simulation models are perhaps most familiar with the precipitation records of the Environmental Data Service (EDS), National Oceanic and Atmospheric Administration (NOAA). In essence, vast amounts of water data are collected periodically by thousands of public and private organizations.

The inconvenience to engineers, planners, scientists and other potential users in dealing with such diverse information systems led to the establishment in 1976 of the National Water Data Exchange (NAWDEX). This confederation is the response to the need for improving the transfer of water data from collectors to users and, thus, constitutes one of its primary missions (Edwards, 1977). As a central source of information on data availability rather than a repository, its success rests ultimately on the strength of its members and their active participation.

A common denominator of mathematical models of urban hydrologic processes is that they require large amounts of data for operation and with which to calibrate and verify model representations of physical processes. Storm-specific information for 41 catchments in 21 cities has been assembled by the University of Florida, under sponsorship of the U.S. Environmental Protection Agency, into an Urban Rainfall-Runoff-Quality Data Base (Huber and Heaney, 1977). The emphasis of such a data base is not the development of an additional storage and retrieval system, but rather its specialized nature. It is anticipated that the actual data will be placed on the EPA STORET system in the future, and in turn indexed eventually by NAWDEX.

USE OF MODELS IN URBAN STORMWATER MANAGEMENT

The enactment by Congress by Public Law 92-500, notably sections 208 and 303 (e), essentially required the development and application of hydrologic and water-quality models by mandating the preparation of area-wide wastewater management plans and river basin waste allocation studies.

Planning and Public Works Agencies

Under contract with the Office of Water Research and Technology, U.S. Department of the Interior, a survey of planning and public works agencies was conducted by Hydrocomp, Inc., of model usage in identifying and evaluating four kinds of water problems (Donigian, 1977):

Hydrology (surface runoff, ground water, water yield, flood frequency)
Hydraulics (streams, lakes, reservoirs, estuaries)
Water Quality (in-stream processes, nonpoint pollution sources, municipal and industrial point sources, environmental impact of pollutant sources)
Economics (project evaluation, benefit-cost analysis, economic impact).

Only urban agencies with a jurisdictional population of 50,000 or higher were sampled, which included all 176 of the designated Section 208 (PL 92-500) planned agencies. Of 2301 questionnaires mailed, 349 agencies (15%) responded. These included 72 Section 208 planning agencies, 41% of the total number designated and 21% of the total number of respondents. Selected results of the survey are presented in tables 1 through 5. It is important to note that 52 percent of the 220 model applications had an impact on the management plan adopted.

Continuous Simulation and Frequency Curves

Rational water resource management must account for hydrologic uncertainty and associated water quality variability. The justification for continuous hydrologic simulation in dealing with problems of urban stormwater runoff quantity and quality is as stated previously, the probability of occurrence of events of various magnitudes (Linsley and Crawford, 1974). The practice of performing frequency analysis on historical data collected from natural phenomena has been in existence for almost a century. Frequency analysis of streamflow data is believed to have been first applied to flood studies by Herschel and Freeman (Foster, 1934). Today, modern electronic computers are used to generate synthetic streamflows because in many cases existing records are not sufficiently extensive to provide estimates of important statistics. Such approximate models are sufficiently realistic to improve the planning process significantly (Fiering and Jackson, 1971).

Table 1.--Agencies Actually Involved in Model Usage[a] (Hydrocomp, Inc., 1977)

	Agencies		Model Applications	
	Number	Percent	Number	Percent
Planning agencies	129	77	174	77
Public works agencies	38	23	46	21
Total	167	100	220	100
Section 208 agencies[b]	(63)	(38)	(91)	(41)

[a]Of the total number of respondents, 48 percent.
[b]Included in totals above.

Table 2.--Categories of Model Use (Hydrocomp, Inc., 1977)

Use	Response	Percent of Response
Water quality	87	40
Storm drainage	59	27
Water supply	49	22
Flood control	44	20
Recreation/environment	7	3

Table 3.--Overall Usefulness of Mathematical Models (Hydrocomp, Inc., 1977)

Absolute evaluation	Response	Percent of Response
Very useful	94	43
Moderately useful	63	29
Not useful	1	0
Relative evaluation		
More useful than alternative methods	111	50
About as useful as alternatives	46	21
No response	62	28
Not as useful as alternatives	1	0

Table 4.--Impact of Models on Decision-Making Process (Hydrocomp, Inc., 1977)

Impact	Response	Percent of Response
Significant	64	29
Moderate	27	12
Critical	19	9
Minor	5	2
Total	115	52

Table 5.--Mathematical Models Most Frequently Identified (Hydrocomp, Inc., 1977)

Model Acronym	Name	Developer(s)
HEC-1	Flood Hydrograph Package	U. S. Army Corps of Engineers
HEC-2	Water Surface Profiles Model	U. S. Army Corps of Engineers
HSP	Hydrocomp Simulation Programming	Hydrocomp Inc.
ILLUDAS	Illinois Urban Drainage Area Simulator	Illinois State Water Survey
RECEIV	Receiving water module of the Stormwater Management Model (SWMM)	Metcalf and Eddy Water Resources Engineers University of Florida EPA
STORM	Storage, Treatment, Overflow, and Runoff Model	U. S. Army Corps of Engineers
SWMM	Stormwater Management Model	Metcalf and Eddy Water Resources Engineers University of Florida EPA

The conventional approach of selecting single design events during critical time periods (low-flow conditions) for water resource management is inadequate for several important reasons:

- No reliable probability of frequency of occurrence can be determined for the single event (Linsley and Crawford, 1974).

- The most critical impact on receiving water quality does not necessarily occur under low flow conditions, because of intermittent urban runoff pollutant shock loads (Heaney and others, 1977).

- Studies have demonstrated that high frequency storms over urban catchments cause significantly greater total annual pollutant loadings from combined sewer overflows than low frequency storms associated with higher flows (Vilaret and Pyne, 1971).

- No accepted design event condition exists which also specifies a design antecedent dry-weather period (Heaney and others, 1977).

- Sizing wet-weather pollution control units for storm intensities associated with the less frequent events (e.g., two year recurrence-one hour duration storms versus two-week recurrence intervals) requires relatively large storage/treatment capacities (Heaney and others, 1977).

Hydrologic Frequency Studies. The traditional attack by earlier statisticians upon the problem of determining theoretical probabilities and expected frequencies has been through the use of the ordinary frequency function. The usual procedure was to find the best fitting function, and then to integrate (infinitesimally or in finite increments) for the probabilities over the given class intervals. The cumulative frequency function is defined as the expected number of occurrences less than a given value; however, it is often also convenient to examine its complement—the expected number greater than or equal to the given magnitude. Expected frequencies in any given range are found simply by taking the difference between two values of the function (Burr, 1942). The flow-frequency, or flow-duration, curve specifically accounts for hydrologic uncertainty in the design and planning of flood-control or drought-relief facilities. The duration curve is the integral curve of the probability curve, and early investigators concluded the latter to be described best by the Gauss-Laplace normal distribution curve (Beard, 1943). A typical flow-duration curve for a hypothetical watershed is illustrated in figure 1. As shown, the probability of occurrence or exceedence is the inverse of the recurrence (return) period.

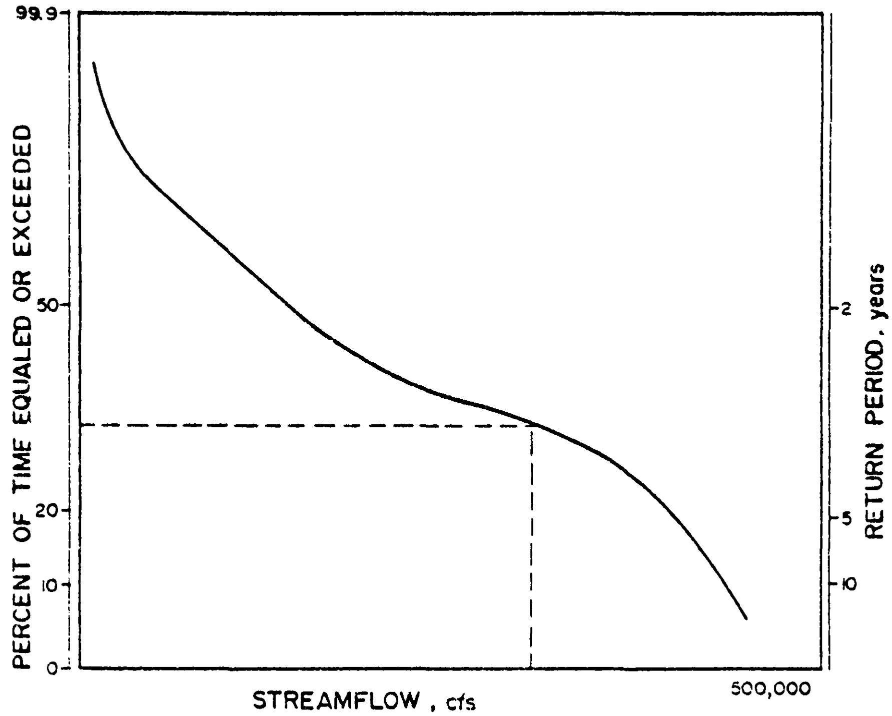

Figure 1.--Flow-Duration Curve
for Hypothetical Watershed.

In later studies, an index of the variation of flow in a stream was developed from duration curves of discharge (Lane and Lei, 1950). An extensive treatise on flow-duration curves is available elsewhere (Searcy, 1959). These curves are considered useful even though the events may not be completely independent of each other; that is, serially correlated (Riggs, 1968).

Water Quality Frequency Curves. In contrast to the century-old practice of frequency analysis for flood control, drought severity, and other quantitative hydrologic applications, its use in water quality control has developed within the last decade. Downstream damages, in terms of water treatment costs at a point, have been related to probability of occurrence or exceedence (Kneese and Bower, 1968). The damages varied according to the dilution provided by streamflow. Cumulative frequency curves have been proposed to relate probability to annual, stream waste-assimilative capacity (Velz, 1970) under natural hydrologic variations. In a study by Hydrocomp International and Black & Veatch of the South Platte River (where the modeling area was centered around Denver, Colorado) minimum dissolved oxygen cumulative frequency curves were compared for various dry-weather wastewater treatment plant configurations (Denver Regional Council of Governments, 1974).

Figure 2 illustrates water quality standard cumulative frequency curves for varying levels of pollutant removal schemes exercised by a hypothetical metropolitan area upstream. At the higher level of control, it is expected that a higher number of events equal or exceed the established water quality standard minimum concentration. Thus, fewer occurrences of water quality standard violations are predicted (Medina and others, 1977).

Model Calibration and Verification.

Deterministic models, as opposed to stochastic models, attempt to represent closely the physical processes and cause-and-effect relationships of the natural system. Regardless of the type of model selected, an assessment or measure of its predictive capability is required. Two distinct sets of field data must be collected for calibration and verification procedures. Calibration is the process of fitting the model output to observed data by systematically varying internal model parameters within reasonable ranges until the closest argreement is achieved. Verification is the process of testing the model to an independently observed set of data using the model parameters derived during calibration. Thus, although identical field gathering techniques are used for both calibration and verification data, the distinction is simply that calibration data must never be used for model verification. The implications of doing so are obvious. Further discussion of data types and collection in subsequent sections applies equally to both of these sets of data.

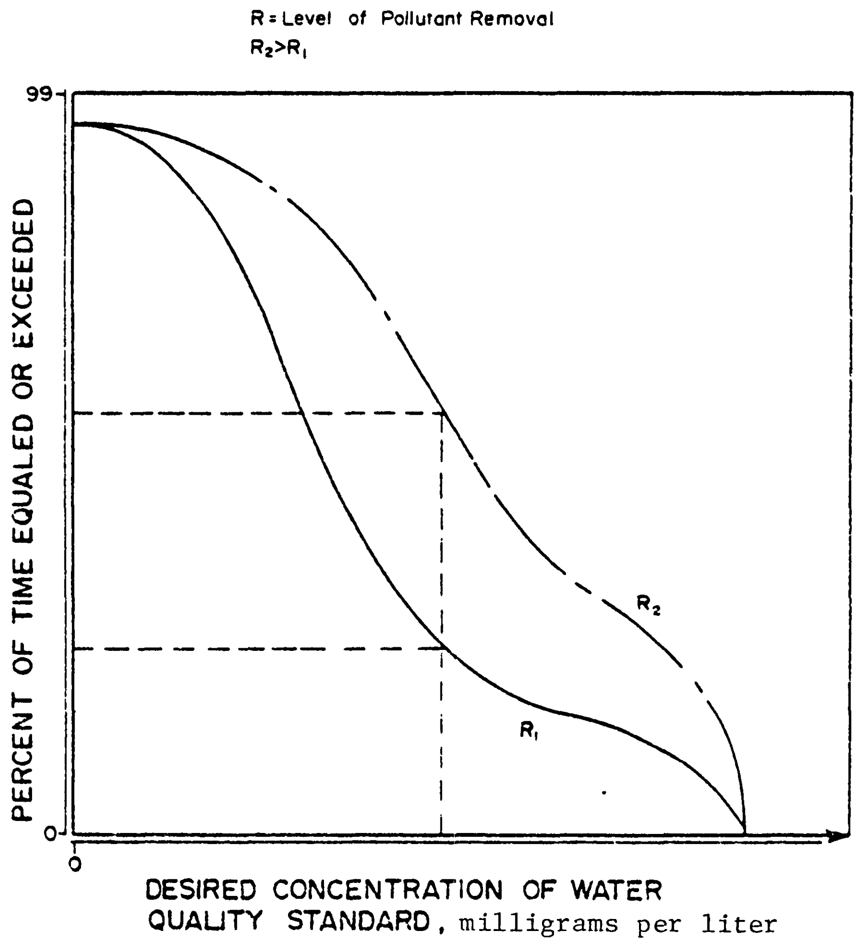

Figure 2.--Cumulative Water Quality Frequency Curves for Hypothetical Watershed.

DATA COLLECTION, ANALYSIS AND UTILIZATION IN STORMWATER MANAGEMENT

Development of a basic data-acquisition network for urban runoff quantity and quality and the characterization of receiving water impacts represents a sizeable investment in manpower and equipment, even when highly automated instrumentation is installed. Therefore, careful consideration should be given to the design of the most efficient sampling program that will meet the desired objectives. General objectives should at least include: (1) definition of the stormwater problem; (2) calibration and verification of mathematical models used to predict the spatial variability and transient nature of stormwater flows, and associated pollutant concentrations and loadings; and (3) some means of monitoring the effectiveness of proposed solutions to the problem (American Society of Civil Engineers, 1977). Frequently, implementation of solutions is unlikely within a short period of time and a decision must be based on a comparison of seemingly equally attractive alternatives. The cost-effectiveness of each measure may be evaluated by investigating the hypothetical response of the receiving body of water to the various control strategies (Medina and others, 1977). Water quality frequency curves (such as figure 2) are extremely useful in making such determinations. Necessarily, consideration must be given to the input data requirements of the models to be used before designing the sampling program. A summary of data typically required in the application of portions of the EPA SWMM (Stormwater Management Model) is presented in the appendix (Huber and others, 1975).

Criteria for Collection

In general, water data collected by Federal agencies (e.g. Environmental Data Service of NOAA; U.S. Geological Survey) have been found to be gathered under standardized, documented procedures (Huber and Heaney, 1977). However, extreme variations are exhibited by almost any other data source, public and private. This is of great concern to the modeling community, which is rarely in control of the data-acquisition phase. Time synchronization of field data operations including water quality sample withdrawal, flow recording, and rainfall measurement is imperative (American Society of Civil Engineers, 1977). This is particularly important in the verification of rainfall-runoff-quality models: to establish accurate rainfall-runoff relationships and hydrograph-pollutograph generation. For example, the basin response time must be determined so that pollutant loads attributed to a storm event may be calculated from concentrations measured in the receiving waters, and from accurate hydrographs. Some typical criteria for collection of quantity and quality data are presented in tables 6 and 7. It is important to emphasize that excellent water-quality data may be rendered useless by inadequate flow information. The types of water-quality parameters sampled should be restricted to those absolutely necessary to satisfy study objectives.

Table 6.--Collection of Water Quantity Data

Rainfall:

Gages — time of occurrence of every 0.01 inch (0.25mm) increment should be recorded, at least one rain gage within catchment.

Discrete, single storm models — rainfall intensity input at 5-minute intervals, 1-minute for small catchments and up to 15-minute for large basins.

Continuous simulation models — hourly precipitation inputs.

Runoff:[a] measured stages from which flows are derived

Calibration — velocity measurements.

Stage-discharge relationships — at weir, flume, orifice constriction.

Theoretical stage-discharge — Manning's equation.

Sampling interval — 1 to 2 minutes on small urban basins.

Time synchronization — with precipitation measurements.

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[a]Standardized U. S. Geological Survey techniques should be used.

Table 7.--Water Quality Indicators[a]

- Physical Parameters:
  - Temperature
  - Turbidity
  - Color
- Chemical Parameters:
  - Oxygen Demand
    - Biochemical Oxygen Demand (BOD)
    - Chemical Oxygen Demand (COD)
    - Total Organic Carbon (TOC)
  - Nitrogen Compounds
    - Organic
    - Nitrite
    - Nitrate
  - Phosphorus Compounds
    - Ortho Phosphorus
    - Poly Phosphates
  - Total Solids
    - Dissolved
    - Suspended
    - Volatile and Fixed
    - Settleable
  - Chlorides
  - Sulfates
  - pH
  - Alkalinity
  - Hardness
  - Heavy Metals
    - Lead
    - Copper
    - Zinc
    - Chromium
    - Mercury
- Biological Parameters:
  - Plankton
  - Periphyton
  - Macrophyton
  - Macroinvertebrates
  - Fish Bioassays
- Bacteriological Parameters:
  - Total Coliform Count
  - Fecal Coliform
  - Fecal Streptococci
  - Total Plate Count

[a]Instantaneous rather than composite sampling is desirable for calibration of predicted pollutographs; 15-minute to hourly intervals. Laboratory analysis should follow procedures in _Standard Methods for the Examination of Water and Wastewater_, American Public Health Association.

Analysis and Utilization

The eventual use of the data determines the proper design of the data-collection program and the selection of the appropriate models for data analysis. The ultimate disposal of urban stormwater runoff is provided by receiving water bodies. Thus, the impact of urban wastewater flows and pollution control strategies such as storage/treatment schemes on receiving water quality constitutes the principal assessment. Such an impact must be related to event probabilities or frequency of occurrence. Within this context, the analyst may choose to use:

planning models - for large-scale metropolitan plans, usually continuous simulation models:

design models - for detailed simulation of sewer network performance, flow regulators, usually discrete single-storm event models; or

operational, real-time models - to actuate flow diversion devices, in-line storage.

Recently, a proliferation in the use of a water quality index (as a function of several water-quality parameters) by regulating agencies has been documented (Ott, 1978). Out of 60 State and interstate agencies, 12 are classified as index users. The National Sanitation Foundation Index (NSFI) is the most commonly used, accounting for 7 of the 12 index users. It includes nine variables: dissolved oxygen, fecal coliform, Ph, 5-day biological oxygen demand (BOD), nitrates, phosphates, temperature, turbidity, and total solids. In 1975, EPA's Region VIII in Denver, Colorado, developed an index based on the frequency of violation of water quality standards (Ott, 1978); it is presented in table 8. Its use in conjunction with water quality frequency curves derived from continuous simulation could be a valuable management tool.

CONCLUSIONS

An ever-increasing need for more field data on quantity and quality aspects of urban stormwater flows is unlikely to diminish in the future. Metropolitan planning agencies, public works agencies, and regulatory commissions are utilizing the predictive capabilities of mathematical simulation models to influence the decisionmaking process and screen water pollution control strategies for point and nonpoint sources. The enormous volumes of data collected must eventually be stored and properly indexed. NAWDEX can play a significant role in (1) the development of recommended standards for the handling and exchange of water data; and (2) in assisting users to identify, locate, and acquire the needed data.

Table 8.--An Index[a] Based On Frequency of Violation of Water Quality Standards (Ott, 1978)

$$I = Z_1^{0.25} \quad Z_2^{0.25} \quad Z_3^{0.125} \quad Z_4^{0.125} \quad Z_5^{0.25}$$

where

Z_1 = percent violation of DO and BOD standards

Z_2 = percent violation of fecal and total coliform standards

Z_3 = percent violation of nitrogen standards

Z_4 = percent violation of phosphorus standards

Z_5 = percent violation of criteria for physical and aesthetic standards

[a]Region VIII, EPA, Denver, Colorado.

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APPENDIX

DATA SUMMARY FOR RUNOFF AND TRANSPORT PORTIONS OF EPA STORM WATER MANAGEMENT MODEL

The Storm Water Management Model is a comprehensive mathematical representation of urban storm water runoff. However, in order for the model to meaningfully assist administrators and engineers in the planning, evaluation, and management of overflow abatement alternatives, good sample data are essential. A summary of the data pertinent to the RUNOFF and TRANSPORT blocks of the model is presented below. Required parameters are *italicized*. Dimensions are usually feet and seconds.

I. RUNOFF BLOCK - used to simulate quantity and quality runoff phenomena of a drainage basin and the routing of flows and contaminants to the major sewer lines.

A. GENERAL - the program accepts data on many parameters:

1. hydrologic conditions - rainfall hyetographs, rainfall infiltration losses, surface detention, antecedent conditions, overland flow, gutter flow

2. physical watershed characteristics - size, ground slope, ground cover (roughness factor), topography

3. urbanization - type and degree

4. land use patterns

B. SURFACE FLOWS - routing of hydrographs through the system by combination of overland flow and pipe and gutter routing.

1. rainfall information -

a. *number* of *storm water inlets*

b. *time* of *start* of *storm*

c. *time-intervals* to be considered

d. *number* of *hyetographs*

e. *percent* of *impervious area* - for immediate runoff

f. *number* of *data points* for each *hyetograph*

g. *rainfall intensity* per interval

h. highest average *30-minute rainfall intensity* (in/hour) if *erosion* is to be modeled in the subcatchment

2. geometric representation of the drainage basin - method of discretization and mathematical abstraction of the physical drainage system. The system is represented as a network of subcatchments, gutters, and pipes requiring characteristics of size, slope, and roughness coefficient

   a. "Fine" grid approach - identify:

      (1) *drainage boundaries*

      (2) *location* of *major sewer inlets*

      (3) *selection* of *gutters/pipes* to be included

      (4) *subdivision* into *subcatchments*

   b. "Coarse" grid approach - identify:

      (1) *drainage boundaries*

      (2) *major sewer inlets*

      (3) fewer *subcatchments* - use of a coarse approach may not significantly affect the runoff phenomena generated

3. estimate of hydraulic coefficients - hydraulic properties of subcatchment

   a. *surface area*

   b. *width, length* - idealized rectangular area with uniform slope and ground cover

   c. *ground slope*

   d. *roughness coefficient*

   e. *detention depth*, if any

   f. maximum and minimum *infiltration rates*

   g. *percent* (%) *impervious*, empirical estimates are available

C. SURFACE QUALITY - these data should be prepared simultaneously with the quantity parameters of RUNOFF block

1. *land uses*

   a. *single-family residential*

   b. *multi-family residential*

   c. *commercial*

   d. *industrial*

   e. *undeveloped* or *parklands*

2. drainage basin *subareas*

3. street cleaning

   a. *frequency*

   b. *number* of *passes* made by sweeper

4. *number* of *catchbasins* - gutter inlets

5. *volume* of *liquid remaining* in the catchbasins

6. *Biochemical Oxygen Demand* (BOD) of *remaining liquid*

7. total *length* of *gutters* - empirical estimates are available

II. TRANSPORT BLOCK - flow routing through the sewer system. A "coarse grid" approach will aggregate several conduits into single composite conduits instead of modeling all individual sewer elements.

A. TRANSPORT MODEL -

1. theoretical data for hydraulic calculations - required only if new shapes are to be modeled. See User's Manual.

2. physical data representing the sewer system - maps and plans are required to illustrate linkages

   a. description of conduits

      (1) *conduit shape*

      (2) *dimensions*

      (3) *Manning's roughness*

      (4) *slope*

   b. description of manholes - require only linkage data

   c. lift stations

      (1) *pumping rate*

      (2) *volume* in wet well at t = 0

   d. flow dividers - require a *priori* delineation of manner in which flow will be divided. Assumed to be independent of downstream conditions. See User's Manual for details.

3. generation of inlet hydrographs and pollutographs - data from RUNOFF block

B. INTERNAL STORAGE MODEL -

1. construction - *natural, manmade* and *covered, manmade* and *uncovered*

2. outlet device - *orifice, weir,* or *pumped*

3. *plug flow* or *complete mixing*

4. basin *flood depth* and its *geometry*

5. *initial conditions* in basin

C. INFILTRATION MODEL -

1. groundwater conditions - *level* of *groundwater table* w. r. t. sewer invert

2. *base estimates* of infiltration - from measurements, historical data, judgment

3. *peak residual moisture*

4. *day* storm occurs

5. average *pipe length*

6. *monthly degree-days* if model run during periods of snow melt

D. DRY WEATHER FLOW MODEL, for combined sewers

1. establish *subareas*, limited to ≤ 200 acres

2. utilize existing *sewer flow measurements* if available

3. daily and hourly *flow variation*

4. US Bureau of Censors data - *population distribution, family income, number* and *age* of *dwellings*

5. *land use activities* - from city records, aerial photographs, on-site inspection.

The program is particularly sensitive to some ot the input data parameters. The quantity portion of the RUNOFF block is sensitive to *imperviousness*, and the quality portion to *land use*. In addition, if extremely high suspended solids (ss) are measured in the qualitative analysis of the runoff, the *erosion* routine should be included when running the RUNOFF block. Also, the *concentration* of *BOD* and the *cleaning frequency* data are very important in the quality model of the RUNOFF block. Accurate data on *topography* and *land use* of *subcatchments* is desirable. It is desirable to calibrate and verify the model using results obtained from measured data. At least two rainfall events not longer than six (6) hours are recommended (2-5 year storms). If the continuous simulation option in RUNOFF is selected, it is advisable to calibrate with data for a particular year and verify model output with data for another year.

THE NATIONAL WATER DATA STORAGE AND RETRIEVAL SYSTEM (WATSTORE) OF THE U.S. GEOLOGICAL SURVEY

by Charles R. Showen[1/]

ABSTRACT

The U.S. Geological Survey investigates the occurrence, quantity, quality, distribution, and movement of the surface and underground waters that comprise the water resources of the United States. As a part of the Geological Survey's program of releasing water data to the public, a large-scale computerized system, the National Water Data Storage and Retrieval System (WATSTORE), was developed to provide more effective and efficient management of data-releasing activities. The WATSTORE system provides for the processing, storage, and retrieval of water data pertaining to surface water, quality of water, and ground water.

INTRODUCTION

The data collected during our field activities are entered into the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). The WATSTORE system provides for the processing, storage, and retrieval of water data pertaining to surface water, quality of water, and ground water. At present (1978), there are 60 Geological Survey remote job entry sites, located in various offices throughout the country, that are equipped with high-speed computer terminals for remote access to the system. At present, there are 36 terminals located in other Federal agencies and 13 terminals located in non-Federal governmental agencies that have access to the system. The primary use of the system by these agencies is to retrieve raw data for further analyses or to use the Geological Survey data files and computer programs to provide standard analytical results.

SYSTEM DESCRIPTION

The WATSTORE system consists of several files in which data are grouped and stored by common characteristics and data-collection frequencies. At present, files are maintained for the storage of (1) daily values, composed of surface-water, quality-of-water, and ground-water data measured on a daily or continuous basis, (2) peak flow data, composed of annual maximum discharge and stage values for streamflow stations,

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(3) water-quality data, composed of chemical and biological analyses for surface- and ground-water sites, and (4) ground-water site-inventory data, composed of hydrologic, geologic, and well-inventory data for ground-water sites. In addition, a Station Header File, an index file of sites for which data are stored in the system, is also maintained (see fig. 1). The system is under constant development to incorporate new techniques and methods of analysis to provide better services to the water-data community. The system is operated and maintained on the central computer facilities of the Survey at its National Center in Reston, Va., and is directly accessible by computer terminals maintained by the Geological Survey, and other Federal and non-Federal agencies.

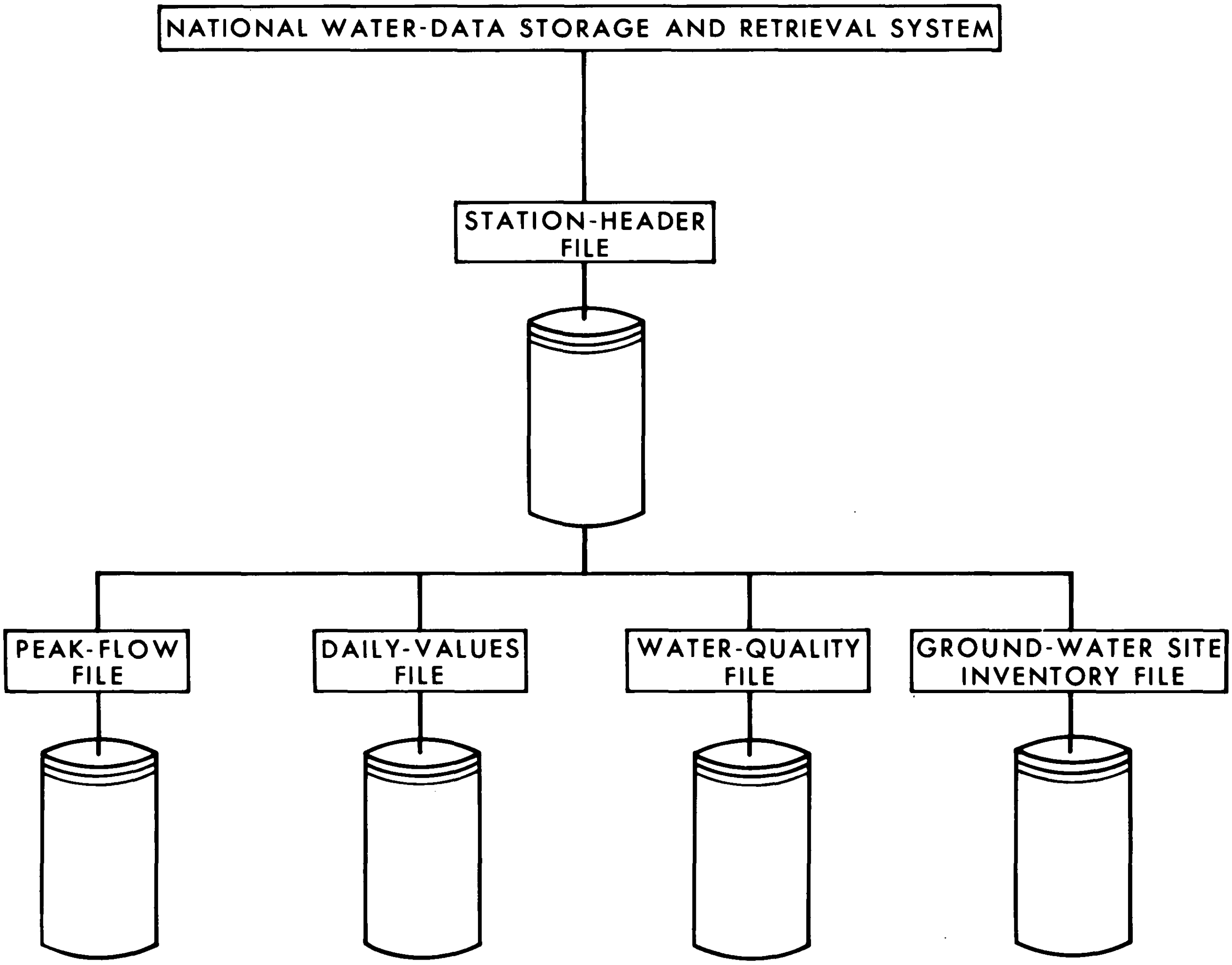

Figure 1.--Schematic representation of WATSTORE files.

Station Header File

The Station Header File contains information pertinent to the identification, location, and physical description of over 193,000 sites for which data are stored in the WATSTORE files. The file serves as an automated index from which a retrieval list of stations may be obtained without searching massive data files. Typical information items stored in this file are: (1) station identification number, (2) station locator (latitude-longitude), (3) State code, (4) county code, (5) station name, (6) drainage area, (7) site-type code, and (8) gage or land surface datum.

A typical example of the use of this file would be to select a group of data satisfying a defined set of criteria, such as to provide a list of stations, located in Fairfax County, State of Virginia, that have a drainage area of less than 50 sq km (19.3 sq mi), for which surface-water data are available in the files.

Daily Values File

The Daily Values File contains water-data parameters measured or observed either on a daily or on a continuous basis and numerically reduced to daily values. Instantaneous measurements of fixed-time intervals, daily mean values, and statistics, such as daily maximum and minimum values may also be stored. This file currently contains over 186 million daily values including data for streamflow values, river stages, reservoir contents, water temperatures, specific conductance values, sediment concentrations, sediment discharges, and ground-water levels.

A generalized retrieval program retrieves records from this file in machine-readable form and passes the retrieved records to computer application programs. Examples of the application programs are:

- Publication tables
- Data inventory of selected portions of the file
- Preparation of X-Y plots on the Calcomp[2] plotter
- Preparation of monthly and annual statistics
- Preparation of duration tables, low- and high-value sequence summaries, and log-Pearson frequency distributions.

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[2] The use of trade names is for identification only and does not imply endorsement by the U.S. Geological Survey.

Water-Quality File

The Water-Quality File contains information pertaining to the chemical, physical, biological, and radiochemical composition of both surface and ground waters. The data stored in this file are obtained primarily through the analyses performed by the two central water-quality laboratories operated by the Geological Survey. The two central laboratories analyze over 150,000 water samples each year. At present, the Water-Quality File contains the results of over 1.4 million analyses of water samples; each analysis may contain data for a maximum of 185 different constituents. The Water-Quality File is used primarily by the Geological Survey. The Survey's water-quality data are also made available through the STORET system operated by the Environmental Protection Agency.

A generalized retrieval program retrieves records from this file in machine-readable form and passes the retrieved records to computer application programs. Examples of the application programs are:

- Publication tables
- Frequency analyses
- Stiff diagrams
- Piper diagrams
- Histograms
- Ratio tables
- Map plots
- Statistical Analysis System (SAS) marketed by SAS Institute, Inc., Raleigh, N.C.
- Plotting and contouring on Calcomp plotters.

Peak Flow File

The Peak Flow File contains the annual maximum (peak) streamflow (discharge) and the annual maximum gage height (stage) values obtained at surface-water sites. It currently contains more than 400,000 annual maximum observations. The primary use of this file is to compute log-Pearson Type III frequency distributions which are used in determining flood-flow frequency.

Ground-Water Site-Inventory File

The Ground-Water Site-Inventory File contains inventory data about wells, springs, and other sources of ground water. The data included are site location and identification, geohydrologic characteristics, well-construction history, and one-time field measurements, such as water temperature and water level. The file is designed to accommodate 209 data elements and currently contains data for over 583,000 sites.

The Ground-Water Site-Inventory File is managed and maintained through a data base management system called SYSTEM 2000. This system is marketed by MRI Systems Corp., Austin, Tex. SYSTEM 2000 is oriented to the collection, maintenance, and manipulation of data en masse, and it provides a report generation capability, a data-base loading facility, a teleprocessing interface, and a query language. Using the retrieval language which is available as a part of SYSTEM 2000, data can be retrieved selectively in a variety of ways. A program to retrieve selected data and prepare publication tables has been written, and programs to interface the file with plotter and statistical routines are nearing completion.

WATSTORE Products

Water data compiled by the Geological Survey are used in many ways by decisionmakers for the management, development, and monitoring of water resources. Thus, in addition to its data processing, storage, and retrieval capabilities, WATSTORE can provide a variety of useful products to meet diverse needs. These products range from simple retrieval of data in tabular form to complex statistical analyses. A wide variety of retrieval options for the system is available, such as,

- Individual station
- Polygon of latitude-longitude
- State
- County
- Aquifer code (for ground-water sites)
- Dates (period of record)
- Values of individual parameters, such as streamflow, water temperature, sediment discharge, etc.
- Greater than or less than specified parameter values.

A summary of the products available is as follows:

1. Computer-Printed Tables: Users most often request data from WATSTORE in the form of tables printed by the computer. These tables may contain lists of actual data or condensed indexes that indicate the availability of data stored in the files. Various formats are available to display the many types of data.

2. Computer-Printed Graphs: Another capability of WATSTORE is to produce computer-printed graphs for the rapid analysis or display of data. Computer programs are available to produce bar graphs (histograms), line graphs, frequency distribution curves, X-Y point plots, site-location map plots, and other similar items by means of line printers.

3. Statistical Analysis: WATSTORE uses the SAS package marketed by SAS Institute, Inc., Raleigh, N.C., to provide extensive analyses of data, such as regression analyses, the analysis of variance, transformations, and correlations.

4. Digital Plotting: WATSTORE also makes use of software systems that prepare data for digital plotting on peripheral, offline Calcomp plotters available at the central computer site. Plots that can be obtained include hydrographs, frequency distribution curves, X-Y point plots, contour plots, and three-dimensional plots.

5. Data in Machine-Readable Form: Data stored in WATSTORE also can be obtained in machine-readable form for use on other computers or for use as input to user-written computer programs. These data are available in the standard storage formats of the WATSTORE system or in the form of punch cards or punch-card images on magnetic tape.

User Charges

The data requester is billed the computer charges associated with the preparation of WATSTORE data in response to his request. There are many variables associated with estimating these charges in advance. Some of the factors are: (1) the amount of data requested, (2) the output format selected, (3) the time frame required by the requester, and (4) whether or not the requester provides the magnetic tape onto which the data are copied. WATSTORE data may be requested through any NAWDEX Local Assistance Center, or contact:

U.S. Geological Survey
437 National Center — Telephone: (703) 860-6879
Reston, Va. 22092 — FTS 928-6879

THE NATIONAL WATER USE DATA SYSTEM AND THE SUPPORT ROLE OF NAWDEX

By Frederick H. Ruggles [1]

On October 1, 1977, the U.S. Geological Survey began the cooperative water-use program. This program is being developed by the Survey in cooperation with State and Federal agencies so that the resulting program can respond to the needs of planners, designers, and water development managers. Considerable activity is currently underway with respect to the description of the water resources of the Nation, and quantitative and qualitative data relative to the availability of surface- and ground-water supplies generally are adequate for most regions of the country; however water-use data are generally lacking.

A number of agencies, both at the Federal and State levels, are interestec in water-use statistics. They are required at the Federal level for the National Assessment to indicate the status and degree of development of the available water resources in the Nation and they are important at the State level where responsibility lies for the actual planning, development and management of the resource. The system is being funded under the Federal-State Cooperative Program, and is to be managed and coordinated by the U.S. Geological Survey, Water Resources Division. The State role in the national system covers two major areas: (1) to provide for the manpower-intensive requirements of the data collection, and (2) to provide for the storage and retrieval of data at the local level where the basic statistics are required by the local planning and management interests. Matching funds are not sufficient in Fiscal Year 1978 to initiate program activities with all States. However, liaison with all States has been established and their interests determined so that as Federal funding and State personnel are available, each State can be brought into the national system as quickly and efficiently as possible.

In Fiscal Year 1978, cooperative programs were established in Alaska, California, Colorado, Florida, Illinois, Kansas, Michigan, North Dakota, Ohio, Pennsylvania, Tennessee, Texas, Utah, Washington, West Virginia, and Wisconsin. In addition, intensive planning has been going on in Maryland, Connecticut, and Virginia.

A National Water Use Data Storage and Retrieval System (NWUDS) which is currently being developed by CACI, Inc., must have a structure which is consistent with the NAWDEX framework, and the following framework reflects the parallelism to the NAWDEX Program Office. The responsibilities of the central NWUDS staff will include (a) regular national summary publications at 2-year intervals (including a new summary series by major-user class); (b) maintenance of a detailed status/capabilities index of contributing data banks; (c) maintenance of a specialized document file in water use; (d) receiving special data requests and allocating necessary response effort

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to contributing data banks; (e) providing specialized software and implementation assistance to State and other component data systems.

State water-use data programs will become the primary contributors to the NWUDS and they will be based on current State systems (where they exist) or current cooperators of the Geological Survey water-use efforts. The Geological Survey will make available data forms and computer programs that will harmonize, where possible, with current State programs. The objective of the State growth programs will be to evolve, in phases, the complete State capability in each major water-user category (irrigation, industrial/commercial, municipal, power generation, etc.). A number of these capabilities will be based on existing Federal data (for example, Census, EPA/CE Permit Program) which the States would incorporate in their data systems, after comparison (and correction) against local knowledge and data sources; this will be a major tool for upgrading Federal data.

Accompanying the phased growth of State data bank systematization will be implementation of specific field measurement programs to improve water-use data accuracy in major areas of current uncertainty such as irrigation, industrial, commercial, and thermoelectric evaporative consumption.

The size of the data base is so large that it sometimes causes one to wonder how all of this data will be stored, retrieved, and indexed. This last need, the requirement to index, is where the water-use program and NAWDEX must interface. To this end, the storage and retrieval systems that are being developed are purposely being shaped so as to minimize the effort necessary to index them in NAWDEX. Doug Edwards, NAWDEX Program Manager, and I have been in constant contact and he has been kept informed of progress in the development of the program. Ideally, we will be able to automatically spin off indexing data from the State-level systems, and insert them into the NAWDEX data base. The Water-Use Program is now an integral part of the USGS data network, and working with NAWDEX, we hope to make this data readily available to the user community.

NEBRASKA NATURAL RESOURCES INFORMATION SYSTEM

By Mahendra K. Bansal[1/]

INTRODUCTION

Legislative Bill 384, passed in the 1969 session of the Nebraska Legislature, directs the Natural Resources Commission to "establish, maintain and administer a data bank in the field of soil and water resources in the State of Nebraska". The passage of the bill does not affect the collection of the basic data, or the necessary interpretations of these data presently done by other agencies. However, such data and necessary interpretations of them shall be made available to the Commission for inclusion in the Data Bank. The Commission has also been authorized to process and analyze this basic data which shall be made available to all interested agencies and persons. The basic data shall mean the recorded observations, calculations, or other information concerning the following:

1) climatological, meteorological, hydrologic, hydraulic, topographic, and geologic conditions and phenomena, including soils and land use,

2) occurrence, quantity and quality of surface-water resources, ground-water resources, waste discharges, and return flows, and variations over time,

3) consumptive and nonconsumptive uses and demands for water, including diversions and extractions; and variations over time,

4) locations, characteristics and operations criteria of works constructed to store, replenish, regulate, divert, extract, transport, distribute, protect and improve surface and groundwater resources,

5) biologic data for streams, lakes, and reservoirs,

6) sediment production, transport, and disposition,

7) water-rights data

8) project and facility operation data,

9) demographic data; and

10) economic and fiscal information data

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A technical advisory committee consisting of 10 representatives of the State and Federal agencies has been appointed by the Governor. This committee shall look over the activities of the Data Bank concerning the collection, interpretation and use of such basic data. The committee shall also help in the coordination and dissemination of the resources of the Data Bank.

DATA BANK ACTIVITY

The Data Bank activity began in early 1970. The initial work consisted of meeting with State agencies and analyzing the extent of their program and data needs. The agencies in other States collecting and processing data were also contacted through a questionnaire to determine the extent of data computerized and the data base management system used in those States. The operation of the Data Bank, called the Nebraska Natural Resources Information System, began with the storage and processing of data which was already available on magnetic tapes in the collecting agencies, such as climatological, streamflow, water quality, and ground-water level data. Standard hydrologic units and sub-units were established for the river basins in the State of Nebraska. All data were identified on the basis of these units and other location information such as county, natural resources district, township-range, latitude-longitude, and the station number.

The data storage and retrieval activities began with the acquisition of climatological data from the U.S. National Climatic Center, Ashville, North Carolina, and the streamflow data from the U.S. Geological Survey, Reston, Virginia. The water-quality data is acquired from the STORET system of the U.S. Environmental Protection Agency. The soil data is computerized from the soil surveys published by the U.S. Soil Conservation Service. The other data such as surface-water rights appropriations; registration of irrigation, municipal and industrial wells; canal diversions; reservoir storage; drain discharges; and conservation and storage-dam data are acquired from the Nebraska Department of Water Resources and it is then keypunched and processed in the Data Bank. The ground-water levels and land-use data is acquired from the Conservation and Survey Division, University of Nebraska. The public health drinking water data is computerized and processed for the Environmental Division of the State Department of Health. The agricultural crop statistics data are gathered from the Crop and Livestock Reporting Service of the Nebraska Department of Agriculture. The data requested by agencies and the public is retrieved and processed in user format. An inventory of the natural resources data currently available in the Data Bank is given in table 1.

DATA ACCESS

The Hydrologic Information Storage and Retrieval System (HISARS), developed at the North Carolina State University (Wiser, E.H., 1975), has been adopted by the Nebraska Natural Resources Information System for storing and processing of climatological and streamflow data. A separate data file

TABLE 1.--Data Bank Resources Inventory (as of December 1977).

Data File	Collecting Agency	No. of Stations	No. of Records	Date Updated To
1. Rainfall	U.S. Climatic Center, Ashville, NC	352	95,120	Dec. 1976
2. Temperature	"	177	54,725	Dec. 1976
3. Snowfall	"	304	43,929	Dec. 1976
4. Evaporation	"	26	3,287	Dec. 1976
5. Events	"	286	26,252	Dec. 1976
6. Water Temperature	"	23	1,545	Dec. 1976
7. Hourly Rainfall	"	77	89,972	Dec. 1975
8. Streamflow	USGS, Reston, VA	257	69,155	Sept. 1976
9. Peak Streamflow	"	371	8,968	Sept. 1976
10. Water Rights	NE Dept. of Water Resources, Lincoln	-	8,801	Sept. 1976
11. Well Registration	"	-	61,292	Dec. 1977
12. Canal Diversion	"	201	23,696	Sept. 1976
13. Reservoir Storage	"	10	2,206	Sept. 1976
14. Misc. Discharges	"	34	2,356	Sept. 1976
15. Groundwater Levels	Conservation and Survey Division, UNL	4,312	91,162	Dec. 1977
16. Dam Inventory	U.S. Corps of Engineers, Omaha	1,516	14,117	Oct. 1974
17. Public Health Drinking Water Monitoring	NE Dept. of Health	638	22,940	Oct. 1977
18. Water Quality (228 Parameters)	U.S. EPA STORET	4,754	223,557	Dec. 1975
19. Agriculture Crop Statistics	NE Crop & Livestock Reporting Service	93	4,743	Dec. 1975
20. Demographic Data, NE Population medium series projections	Bureau of Business Research, UNL			
(a) By county & age group		93	4,320	1970 Census
(b) By county, sex & race		93	558	1970 Census
21. Soil Interpretative	U.S. SCS, Nebraska	Sarpy, Seward, Gage, Thayer, Webster, York, Nuckolls, Adams, Harlan, Douglas, Hall, Jefferson, Polk, and Phelps counties		
22. Land Use	Conservation and Survey Division, UNL	Sarpy County	540	1976
23. Center Pivot Information	"	Acquisition of data is in progress.		

is maintained for each kind of data information. HISARS employs index-sequential access method of data organization. There is, therefore, an index file associated with each data file. The water-quality file has three levels of data organization. There is also a parameter file along with the index and data files. The other kinds of data information are simply set up as sequential data files. The streamflow and climatological index files contain the following information for each station.

1) STATION number,

2) COUNTY name and/or number,

3) NRD name and/or number,

4) BASIN number,

5) latitude-longitude or township-range-section LOCATION information,

6) ELEVATION of recording stations,

7) drainage AREA for streamflow stations, and

8) PERIOD of record.

The underlined commands help in programmable access of information for different geographic location blocks at the same time for various periods of record. The index-sequential access increases the scanning speed of the records within a file. The data retrieval is also, therefore, optimized.

For the types of data like streamflow, temperature and evaporation which are recorded fairly regularly, a fixed length format is used. Each record contains the daily values for a month and the monthly total. The number of days in the month is also recorded which is used to control the number of days read or recorded. For the type of data file like rainfall, snowfall, events, and peak flow which are recorded erratically, a variable length format is used. Each daily data is a separate record and is recorded for only those days for which the observations are reported. This has proven to be more efficient that storing a complete month of record. A fixed-length format is sometimes preferred over a variable-length format when there is an apparent gain in processing and programming. The data files are organized so that the records for each station are grouped together in natural sequence. But they can be accessed randomly through index-sequential access method.

DATA PROCESS AND MANAGEMENT

Three kinds of output options are available. They are list, copy, and plot options. The LIST command produces listings of the data accessed or processed. It can be the index or station information, hourly or daily listings, monthly or annual summaries, and statistical or hydrologic processing of data. The COPY command is available to copy basic data onto a magnetic tape or a direct access device. The data records are copies in the order they are accessed, or in a format requested by the user. The PLOT routine is used to plot the locations of recording stations, or registered wells in a county, township, or Natural Resources District (NRD). The map can be plotted to any scale drawn on Lambert-conical projections. A CALCOMP plot is limited to its 30 inch plot size paper. If the scale requires the plot to be more than 30 inches, the map is split into parts. The soil interpretative maps are reproduced directly from the computer printouts. The scale is devised such that the horizontal and vertical scales transform the plot into print positions of a printer. The reduced scales would, therefore, conform to 10 characters per inch horizontally, and six or eight lines per inch vertically. The computerized soil surveys are interpreted for the following soil characteristics.

1) Land slope
2) Hydrologic group
3) Permeability
4) Drainage
5) Shrink-swell potential
6) Suitability for septic tank absorption fields, sewage lagoons, sanitary landfills, dwellings with basements, local roads, and prime farmlands
7) Erodibility K-factor
8) Allowable soil loss (T-value)
9) Potential sediment yield
10) Wind erosion
11) Dryland capability, and
12) Irrigability.

Similarly, the level I and level II land use classification maps are reproduced from the Landsat imagery data computerized for certain counties in the State. The crop statistics and projections concerning acres harvested, yield, and production are worked out for major crops in the State. The data available is analyzed for irrigated, dryland, and total cropland, respectively. The following crops are included.

1)	Corn for grain	Irrigated, dryland and total
2)	Sorghum for grain	Irrigated, dryland and total
3)	Winter wheat	Total only
4)	Summer fallow wheat	Total only
5)	Continuous cropland wheat	Total only
6)	Total wheat	Total only
7)	Soybeans for beans	Irrigated, dryland and total
8)	Alfalfa hay	Irrigated, dryland and total
9)	Wild hay	Total only
10)	All hay	Total only
11)	Dry beans	Total only
12)	Oats	Total only

13)	Sugar beets	Total only
14)	Barley	Total only
15)	Rye	Total only
16)	Alfalfa seed	Total only
17)	Potatoes	Irrigated, dryland and total
18)	Corn for silage	Irrigated, dryland and total
19)	Sorghum for silage	Irrigated, dryland and total
20)	Sorghum for forage	Total only

Besides HISARS utilities, various other hydrologic and statistical processing routines have been extended. Some of the processing facilities available in the Data Bank are listed in table 2. The township-range information can be converted into latitude-longitude coordinates. Information such as surface water rights, hydrographic reports, dam inventory, public health drinking water data, crop statistics and well registrations are retrieved in the form that they can be published directly from the computer printouts.

The information which the Nebraska farmers use more often is the ground-water well-registration data. This data is, therefore, updated on a quarterly basis, and the information can be retrieved by county, NRD, or registration number. The information such as acres irrigated, number of (irrigation, municipal or industrial) wells drilled or registered by year, is sorted and summarized by county and NRD. The well registration data is also frequently requested by the county assessors offices, natural resources districts, public power districts, and other insurance and banking institutions in the State.

The data management is carried out to perform additions, modifications, or deletions of records in the index and data files. Special system utility programs exist to create new data files or to add large quantities of data to the existing files. In sequential files, the data are copies onto a second device, the records added, updated and sorted to manage information in the data file. Password protection is provided to prevent unauthorized access to the data files. The data files are updated on a regular basis.

WATER DATA

The surface water data available in the Natural Resources Data Bank consist of surface water rights appropriations, daily streamflows, peak flows, canal diversions, dam storage, and miscellaneous discharges of drains and ditches. The water rights information is organized sequentially, while the other data files are organized index sequentially. The streamflow data can be retrieved in the form of index listings, average daily streamflows, or mean monthly summaries. Some standard statistical and hydrologic processings of data are also available. These include simple regression and correlation analyses, mass curve and duration analyses, and low flow and high flow frequency analyses. The water data information is valuable in water-resources planning, study of floods and droughts, and water requirements

TABLE 2.--Data Retrieval Library

1. Listing (daily, monthly, annual) of climatological, or streamflow data by county, NRD, basin, or geographic location block.

2. Listing of well registration, water rights, water quality canal diversion, reservoir storage, dams inventory by county, NRD, or station number.

3. Listing of daily or monthly maximum, minimum, or extreme temperatures.

4. Listing of daily occurrences of individual events.

5. Listing of demographic data for counties by age, color, or sex.

6. Search of hot or cold days, dry or wet days, frost-free and snowfall amounts in Nebraska.

7. Daily or monthly statistical summaries for rainfall or streamflow stations.

8. Cumulative frequency distribution for daily, monthly rainfall or streamflow data.

9. Rank order analyses of rainfall or streamflow in descending order.

10. Mass analyses of monthly streamflow or rainfall.

11. Auto-correlation analysis of daily rainfall stations.

12. Low flow frequency analysis for streamflow stations (7 day, 10 year low flows).

13. High flow frequency analysis for streamflow stations.

14. Flow duration table or curve for streamflow stations.

15. Plot of registered wells drawn to any scale on Lambert conical projections for the state, county, township, or NRD.

16. Agriculture crop statistics by county, extension area, division or state totals for various crops in the state.

17. Soil interpretative maps for various counties in the state.

18. Punched deck or copy of basic data onto a magnetic tape or any direct access device.

in a drainage basin or a region. The efforts to store streamflow hydrograph data for Nebraska is in progress. This would be valuable for surface-water modeling efforts. Similarly, the synthetic streamflow data for the streams for which channel flows are not recorded shall be analyzed in the Data Bank.

The ground-water data consist of ground-water levels information and well registrations in the state. The water-table information can be retrieved and plotted by year for each observation well in a county. The surface and ground-water quality data are summed up by parameter, date of observation, and station number. This information has proved to be quite useful in water quality planning and management of point-source, and area wide pollution studies of streams and river basins in the state.

CONCLUSIONS

The Nebraska Natural Resources Information System was established to store, process, organize and manage basic soil and water data pertaining to the State of Nebraska. This data is greatly needed during planning, development, and formulation of water-resources projects. The Data Bank should prove to be of great assistance to the State, local, and Federal agencies, and the public by providing them with adequate data. The users and the public are greatly encouraged to make maximum use of the Nebraska Natural Resources Information System, administered by the Natural Resources Commission.

A Data Bank manual is published from time to time to acquaint the users with the resources and facilities of the Data Bank. The first publication (Nebraska Natural Resources Commission, 1973) was published in June 1973. The revised version (Nebraska Natural Resources Commission, 1978) was presented in March 1978. The contents of the manual are designed to provide self-explanatory information about each type of data that might be useful to the users. A sufficient number of processing examples have been displayed in the manual illustrating the use and format for which the data can be accessed, retrieved or processed. The services of the Data Bank are free and are user-oriented for all government and public use.

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SNOTEL

By Bernard A. Shafer[1] and Michael Burke[2]

Introduction

The Soil Conservation Service (SCS), U.S. Department of Agriculture, has the responsibility for coordinating the Cooperative Snow Survey Program in the Western United States, excluding California. This program has been operating since the early 1930's. The program's primary purpose is to measure the snowpack accumulating in the mountains during the winter months and then issue forecasts of expected spring and summer streamflow. Runoff from snowmelt contributes approximately 75 percent of the total flow of many streams in the semiarid Western United States. To index the snowpack and predict runoff, 1,700 snow courses are read manually once each month during the late winter and early spring.

With increasing demands for water in a region where water is frequently scarce, better water management and conservation have become necessities. Agriculture, which consumes 80 to 95 percent of the region's water supplies, must now compete with municipal and industrial uses. In our business we have a motto which typifies our approach to better water conservation, particularly on farms and ranches: "The conservation of water begins with the snow survey." Because agriculture is the largest user of water in the West, our snow survey and water supply forecasting program has been directed at providing as much advance information as possible so that available water can be wisely allocated and acres and cropping patterns balanced. Other users also benefit from snow survey data. These include municipalities, hydroelectric power generation facilities, reservoir managers, fish and wildlife commissions, land use planners, and recreation area developers.

As demands mounted for more accurate and timely forecasts of steamflow, it became apparent that data gathered more frequently than once a month were required. From the mid-1960's and into the early 1970's, SCS developed and tested new snow sensors. Various states installed conventional very high frequency (VHF) radio telemetry systems with mountaintop repeaters to transmit data from these sensors to central base stations. These types of systems were expensive to install and maintain and were frequently subject to lengthy periods of inoperation leading to loss of considerable data. A better method was needed to retrieve data from remote mountain sites.

Toward this end, Congress appropriated funds in 1975 to initiate the study and implementation of a SNOTEL (SNOwpack TELemetry) system. Systems Consultants, Inc. (SCI) of San Diego, California, was employed to summarize user needs for data, evaluate applicable data transmission systems, and

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recommend the system most appropriate for SCS. The three most promising among the systems analyzed were conventional VHF radio with mountaintop repeaters, satellite telemetry, and forward scatter meteor burst. SCS concluded that the meteor burst technique was the best method suited to transmit very short data bursts at periodic intervals from widely scattered remote sites in near real time. Their conclusion was based in part on a number of recent advancements in digital electronics that enable a relatively small central facility to control a large data retrieval network with a very fast turnaround time. Meteor burst communication is not new; knowledge of how it operates has existed for over 25 years. Its application for remote data gathering, however, is a relatively recent innovation.

In principle, the system uses the reflection of VHF signals by ionized meteor trains to enable communication between remote sites and a master station separated by as many as 1,200 miles (fig. 1). Data rates for transmission and reception utilizing meteor burst communications vary on a seasonal and diurnal basis according to the number of meteor trains available. However, the frequency of transmissions, even during the worst time of year and worst time of day, is sufficient to provide adequate responses for the relatively low data rates characteristic of SNOTEL.

System Requirements

In designing the SNOTEL system, several criteria needed to be considered. Six major factors dictated the overall system design: type of data collected, geographical coverage, system responsiveness, user characteristics, data processing requirements, and remote site operation and maintenance.

Initial requirements for physical sensors at a remote site were limited to snow water equivalent, ambient air temperature, total precipitation, and battery voltage. However, it was recognized that additional sensors would be desirable at some locations. These might gather data on wind run, soil moisture, solar radiation, humidity, etc. To accomodate this eventuality the system required a sensor expandability feature.

The system was designed to cover most of Western United States (fig. 2). It covers 10 Western States for a total of approximately 2,000,000 square kilometers. Within this area, data site locations were to be minimally constrained by the communication system features, i.e., landline or repeater links. The system was also required to accomodate data site population growth without an overall system redesign.

System responsiveness was a very important design factor. To meet forecasting and special user requirements, data were required on both a daily scheduled basis as well as on demand with response times not exceeding 1 hour. This last constraint dictated the capability for remote site interrogation.

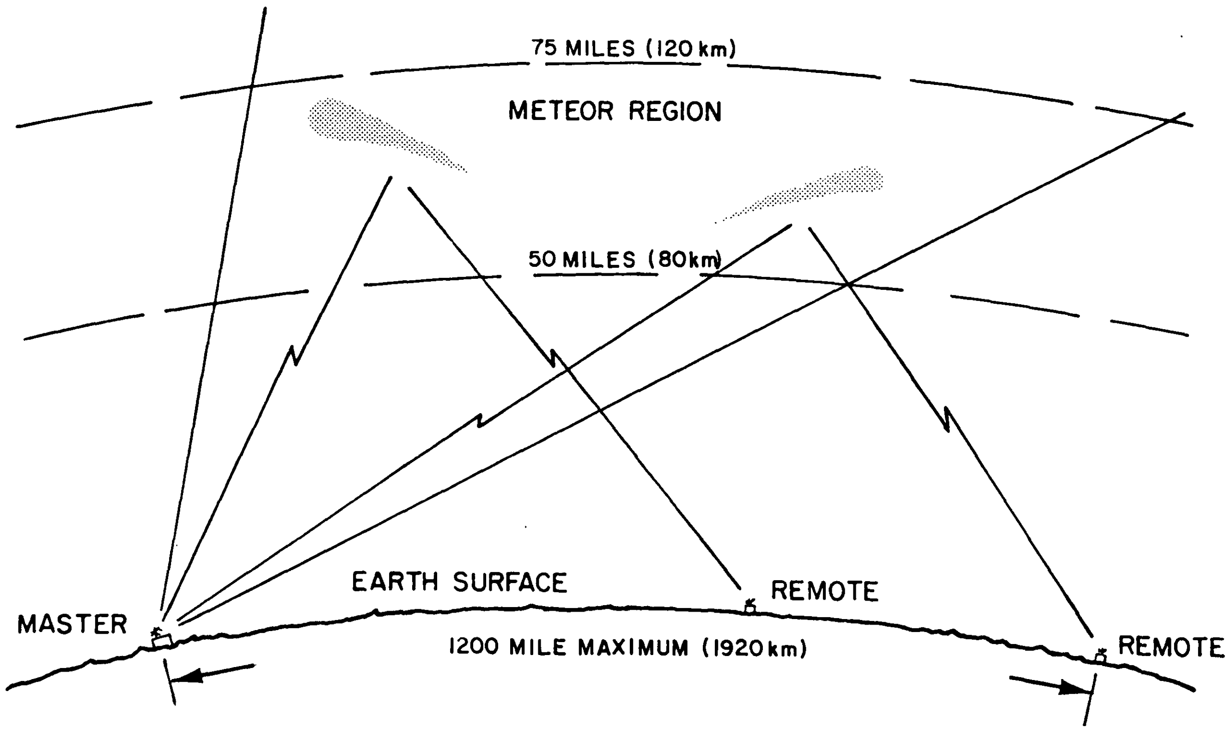


Figure 1.--Meteor burst data acquisition system.

Figure 2.--Approximate system coverage of the Western United States.

Access to SNOTEL data was not limited to SCS. Other users with varied applications from widely divergent fields required access to the system. Outside user requirements spanned the range of access from daily to hourly to on-call interrogation during emergency events. For example, data needs for avalanche forecasting differ significantly from those for operating a hydroelectric power generation facility or for flood forecasting during a major storm event. Although the SNOTEL system was not specifically designed for these needs, an attempt was made to meet them where practical.

Since data from a near-real-time system are generated so rapidly and since their utility is affected to a great extent by their timeliness of delivery, the system's data processing facilities became a critical design consideration. In addition to handling the day-to-day system operation of data retrieval, validation, accessing and archiving, it was necessary to provide for data exchange with a user community beyond SCS. Both hardware and software components needed to be expandable to meet the expected growth in the number of remote sites, types of sensors, outside user requests, and computer-to-computer data exchanges.

Remote site operation also influenced the system design to a large extent. Each remote was required to operate continuously unattended for as long as 1 year in severe environmental climates. This implied a self-sustaining power source. Remote site sensor and transmission components were required to be modular for ease in maintenance and replacement.

With the above design requirements in mind, a plan for the system evolved and is currently being carried out. SNOTEL consists of four components separated by function. These components are user oriented and flexible in terms of access and expansion. The components are remote sites, master polling stations, the central computer, and remote computer terminals (fig. 3).

Central Computer

The central computer is the heart of the SNOTEL system. It is a Hewlett Packard 9640A multiprogramming system operating under the RTE-II real-time executive software. The system includes 20 million bytes of disc storage and two magnetic tape drives for storing data. The central computer drives the SNOTEL system from the SCS West Technical Service Center in Portland, Oregon. This computer issues commands to two master stations, one in Boise, Idaho, and one in Ogden, Utah, causing them to poll individual remotes or groups of remotes. The central computer collects and validates the data from the masters and makes the data available to users. Leased telephone lines provide the communications link between the central and master stations and also between master stations themselves. Data rate transfer over the leased lines is at 1,200 bits per second.

The central computer issues commands in two modes to the master stations. The first mode results in polling all remotes in the network on

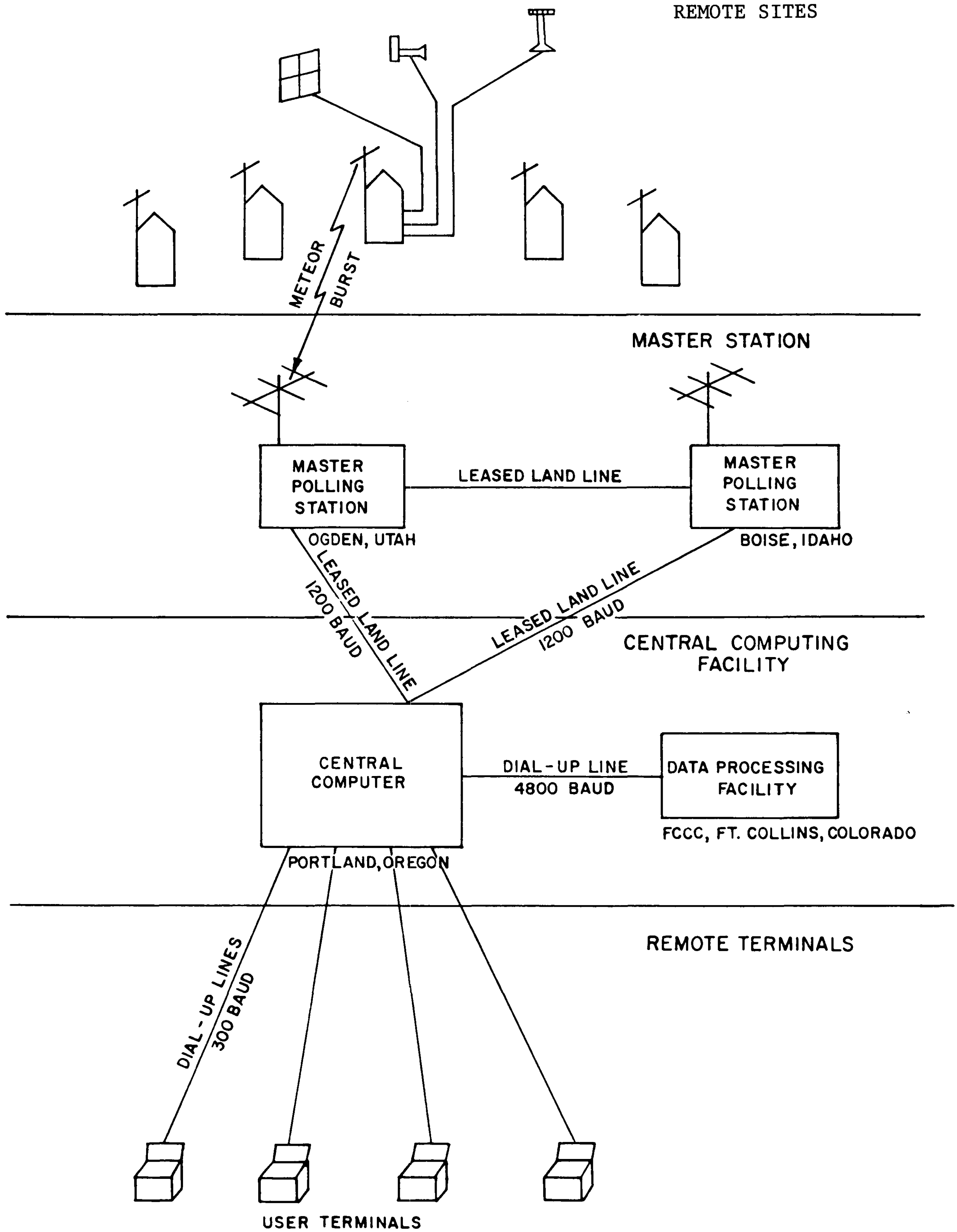


Figure 3.--SNOTEL system architecture.

a periodic basis, nominally twice daily at specified times. The second mode is a special polling of individual remotes that is initiated by SCS state snow survey supervisors from their remote terminals. Thus, individual remotes may be interrogated on a special one-time-only basis or on a more frequently scheduled basis (e.g., 8 times/day) restricted only by the power budget at the remotes.

The central computer provides a variety of reports to users who request them and even allows users to create their own formats. Access by non-SCS users requires approval of the state conservationist of the state from which they wish to receive remote site data.

Automatic validation of all incoming data is performed by the central computer. Any data not meeting certain "window" criteria are flagged for further scrutiny and manual validation by the state snow survey supervisor who has jurisdiction over the site in question. Flagged data are not available to outside users until manually validated by the appropriate snow survey supervisor.

Special storm alerts are automatically sent by the central computer to the appropriate supervisor's office when precipitation rates exceed specified threshold limits established on a state-by-state basis.

Data are held on-line at the central computer for a limited period of time before they are sent to the USDA Fort Collins Computer Center (FCCC) in Colorado for archiving and further manipulation. FCCC will act as the final repository of all SNOTEL data. Data transfer to FCCC is by dial-up telephone lines at 4,800 bits per second.

Master Stations

Two master polling stations are used to send the required polling signals to the remote stations and gather data from them. The dual master stations have a twofold purpose. First, a measure of redundancy and thus increased reliability is achieved, since each master is able to communicate with every remote, although with decreased responsiveness. Second, each remote is assigned selectively to the master; this maximizes the responsiveness given the remote's topographical position and distance from each master.

Each master includes Data General NOVA 3/12 minicomputer with 16K of resident core memory to control operations. A teletype for local command entry is the only peripheral device to this computer. Each master is capable of storing 3 days' data in the event that landline outages prevent the forwarding of data. Both masters are designed for unattended operation.

When a master station is commanded to poll a remote site, a polling signal is continuously transmitted with that remote's unique address. When a meteor enters the Earth's atmosphere at the right height and angle, it provides an ionized trail that acts as the reflecting medium for the polling signal to reach the remote station. The remote recognizes the polling signal and transmits the current data back to the master station using the same reflective path. The entire sequence from master to remote and back usually takes about two-tenths of a second once a reflective path is established. The same technique can be used to poll groups of remotes by generalizing the address in the polling signal through the use of redundant bits so that more stations will respond. When a master station polls a large group of stations, e.g., 100 or more, each will nevertheless answer individually because of the selective nature of the meteor trails available. The master keeps track of each remote and the time when it responds by noting its unique address, which is transmitted with the sensor data stream.

Remote Stations

Some 511 planned remote stations are the backbone of the SNOTEL system. Each remote consists of sensor equipment and communications gear. A standard site has sensors to record snowpack water equivalent, total precipitation, and ambient air temperature. All sensors currently in use produce an analog signal that is converted to a digital value for transmission. Although the number of sensors at each site is currently set at four, the system is designed to receive inputs from as many as 16 sensors. This feature can be used in comparative testing of new sensors such as new snow pillow designs and nuclear gages that measure precipitation and snow water equivalent. Other types of sensors may be added to monitor soil moisture, solar radiation, and wind.

Each remote is powered by a battery that is trickle-charged from single or multiple solar cells. The power system is designed for a 1-year maintenance-free duty cycle.

The communications electronics at each remote station are housed in a 4- by 4- by 8-foot shelter along with associated pressure transducers and plumbing. The electronics consist of the equipment necessary to detect, interpret, and respond to master station probes and to perform analog-to-digital conversion, sensor interfacing, and data buffering. A folded dipole antenna is mounted on a tower with the solar cells immediately outside the shelter. Figure 4 is a schematic of a typical site configuration.

The operation of the remote station is fairly simple. Every 15 minutes the sensor interface electronics are activated, the sensors are sampled, and the data are converted to digital format and stored in a buffer for transmission. Thus, when the site responds to a poll, the data sent are no more than 15 minutes old. Meanwhile, the VHF receiver is constantly active and awaiting the arrival of a polling signal addressed to that remote station. The receiver and control logic are designed to ignore unwanted noise; even valid signals addressed to other stations are ignored. However, when a suitably addressed signal is detected, the transmitter is activated and the buffered data are transmitted.

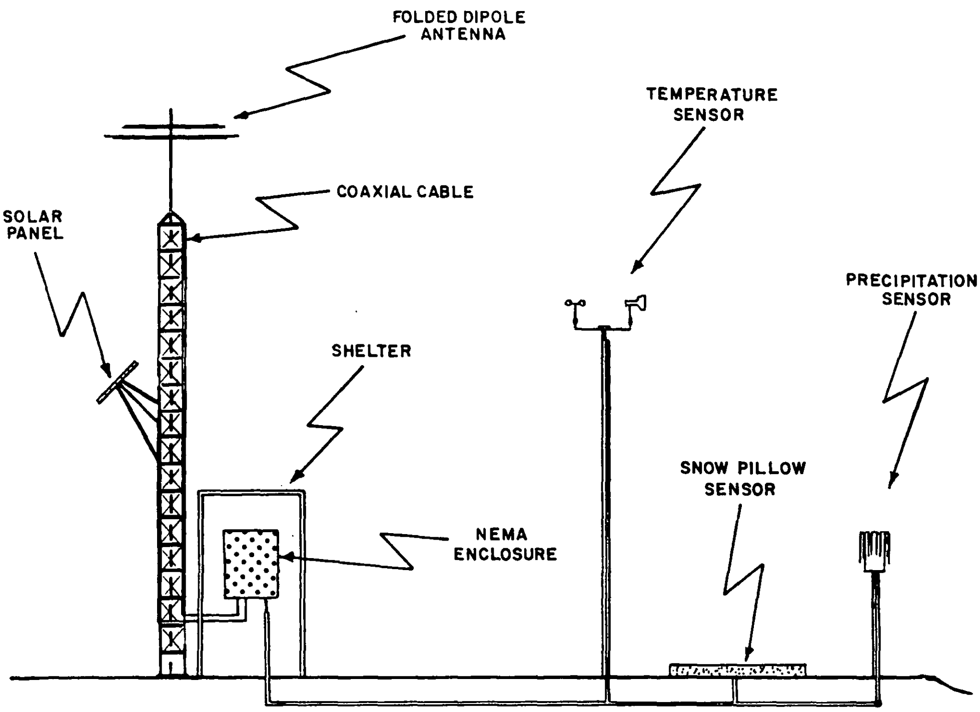


Figure 4.--Remote station configuration.

Remote data sites may also be configured to operate with stream gaging stations to telemeter periodic river stage readings and, quite probably, water quality characteristics as well.

Since the system will operate year round, data may be collected for use in areas such as fire weather reporting, and environmental impact studies.

User Access

SCS SNOTEL users access the system from remote computer terminals via dial-up telephone circuits operating at 1,200 bits per second. At present, each of nine snow survey supervisors has a terminal consisting of a keyboard and cathode ray tube for input and output as well as a thermal printer for permanent copy. From these terminals, users can log onto the system and issue requests to the central computer.

Requests to the computer can take many forms. SCS users may request on-line data reports, validate data, initiate polling (authorized personnel only), change polling schedules, and create new reports. All data exist in two forms, raw and validated, and can be retrieved upon request.

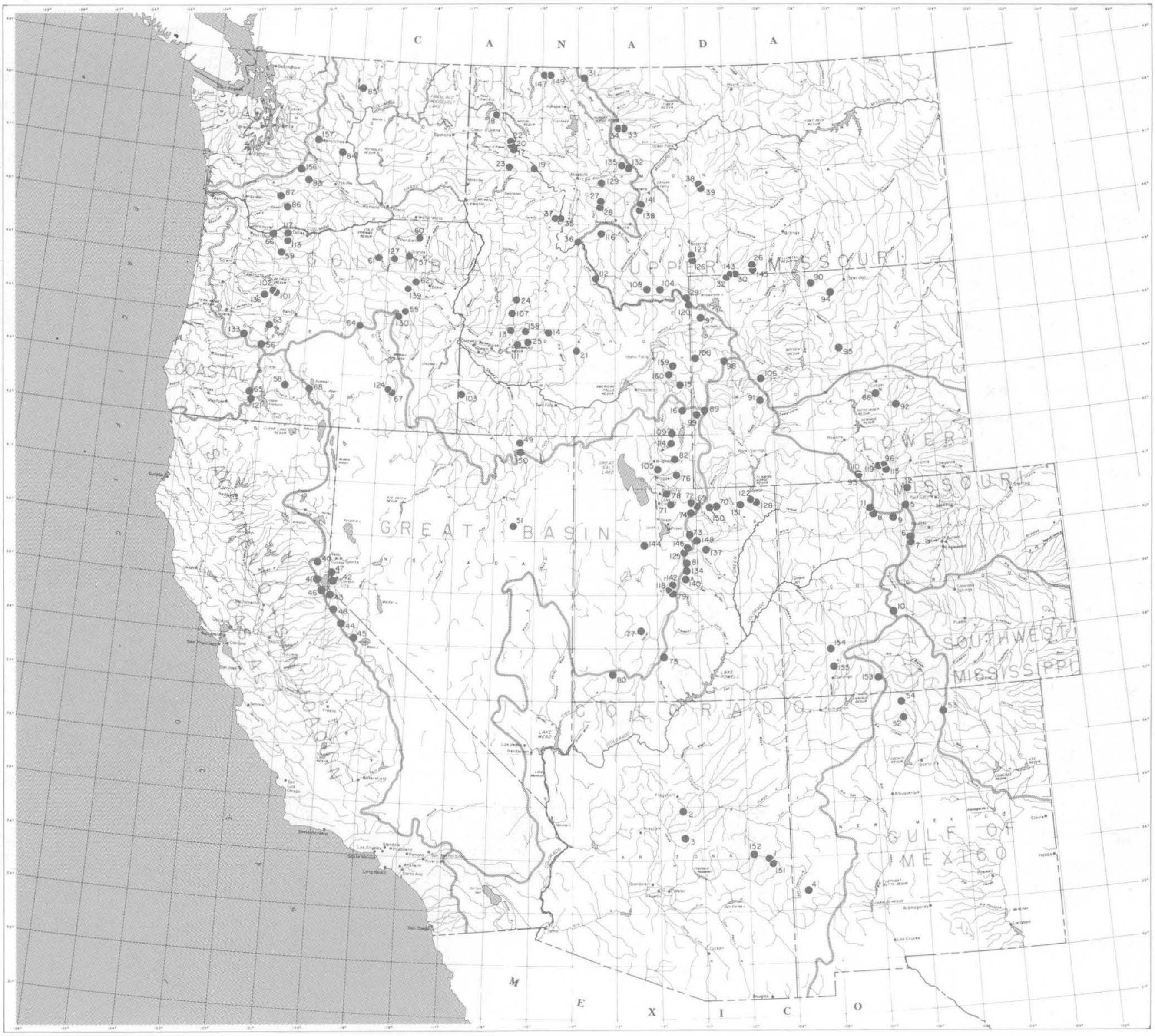
Non-SCS users will be restricted to receiving data reports, generally for validated data only. Access to these data are now provided by a 300-bit-per-second dial-up line. Authorization to access the system must first be obtained from the appropriate snow survey supervisor's office.

SCS and non-SCS users may also gain access to the data via the FCCC, where the data are archived and where most of the data processing is done. Access via the FCCC is governed by the same procedures that apply to data from other sources.

Project Status

Currently, 160 remote sites have been installed (fig. 5). Both master stations are operating, as is the central computer. Work is progressing on the installation of the remaining remote sites, with completion targeted for 1980. The communication electonics for the SNOTEL system are being furnished under contract by Western Union.

Performance tests of the first 160 sites are continuing. These tests call for systemwide polls to be completed within 1 hour. For on-demand polling, the tests require receipt of data within one-half hour. Allowing for the random nature of meteor trails, the systemwide time limits must be met 95 percent of the time. Preliminary results have indicated that these requirements can be met even during February, the worst time of year for exploiting meteor trails.



INDEX TO SITES

1 BALDY, AZ
2 MORMON MOUNTAIN, AZ
3 BAKER BUTTE, AZ
4 SILVER CREEK DIVIDE, CO
5 JOE WRIGHT, CO
6 ARROW, CO
7 BERTHOUD SUMMIT, CO
8 COLUMBINE, CO
9 WILLOW CREEK PASS, CO
10 PORPHYRY CREEK, CO
11 TOWER, CO
12 DEADMAN HILL, CO
13 MOORES CREEK SUMMIT, ID
14 GALENA SUMMIT, ID
15 SOMSEN RANCH, ID
16 SLUG CREEK DIVIDE, ID
17 LOOKOUT, ID
18 MOSQUITO RIDGE, ID
19 VIENNA MINE, ID
20 ABOVE BURKE, ID
21 SWEDE PEAK, ID
22 SUNSET, ID
23 FORTYNINE MEADOWS, ID
24 DEADWOOD SUMMIT, ID
25 ATLANTA SUMMIT, ID
26 COLE CREEK, MT
27 COMBINATION, MT
28 BLACK PINE, MT
29 WHISKEY CREEK, MT
30 WHITE MILL, MT
31 FLATTOP MTN., MT
32 NORTHEAST ENTRANCE, MT
33 WALDRON, MT
34 MOUNT LOCKHART, MT
35 TWELVEMILE CREEK, MT
36 SADDLE MTN., MT
37 TWIN LAKES, MT
38 DEADMAN CREEK, MT
39 SPUR PARK, MT
40 INDEPENDENCE CAMP, NV
41 WARD CREEK #3, NV
42 MARLETTE LAKE, NV
43 HAGAN'S MEADOW, NV
44 SONORA PASS, NV
45 VIRGINIA LAKES, NV
46 FALLEN LEAF, NV
47 MT. ROSE, NV
48 EBBETTS PASS, NV
49 BEAR CREEK, NV
50 SEVENTYSIX CREEK, NV
51 CORRAL CANYON, NV
52 BATEMAN, CO
53 RED RIVER PASS #2, CO
54 HOPEWELL, CO
55 BLUE MOUNTAIN SPRING, OR
56 SUMMIT LAKE, OR
57 BOWMAN SPRINGS, OR
58 TAYLOR BUTTE, OR
59 MUD RIDGE, OR
60 HIGH RIDGE, OR
61 ARBUCKLE MTN, OR
62 BOURNE, OR
63 IRISH TAYLOR, OR
64 SNOW MOUNTAIN, OR
65 BILLIE CREEK DIVIDE, OR
66 NORTH FORK, OR
67 FISH CREEK, OR
68 SUMMER RIM, OR
69 TRIAL LAKE, UT
70 LAKE FORK MTN, UT
71 PARLEY'S SUMMIT, UT
72 SMITH & MOREHOUSE, UT
73 STRAWBERRY DIVIDE, UT
74 BEAVER DIVIDE, UT
75 WIDSTOE ESCALADE #3, UT
76 HORSE RIDGE, UT
77 BIG FLAT, UT
78 FARMINGTON (UPPER), UT
79 PICKLE KEG SPRINGS, UT
80 KOLOB-CRYSTAL, UT
81 MAMMOTH-COTTONWOOD, UT
82 MONTE CRISTO, UT
83 BUMPING RIDGE, WA
84 TROUGH, WA
85 PARK CREEK RIDGE, WA
86 SURPRISE LAKES, WA
87 LONE PINE SHELTER, WA
88 CASPER MTN., WY
89 SPRING CREEK DIVIDE, WY
90 BALD MTN, WY
91 BIG SANDY OPENING, WY
92 LAPRELE CREEK, WY
93 OLD BATTLE, WY
94 DOME LAKE, WY
95 MIDDLE POWDER, WY
96 ARRASTRE LAKE, WY
97 LEWIS LAKE DIVIDE, WY
98 GROS VENTRE SUMMIT, WY
99 SALT RIVER SUMMIT, WY
100 PHILLIPS BENCH, WY
101 HOGG PASS, OR
102 SANTIAM JCT., OR
103 SOUTH MTN., ID
104 TEPEE CREEK, MT
105 BEN LOMOND PEAK, UT
106 ST. LAWRENCE, WY
107 COZY COVE, ID
108 DIVIDE, MT
109 FRANKLIN BASIN, ID
110 WEBBER SPRINGS, WY
111 TRINITY MTN., ID
112 LEMHI RIDGE, MT
113 RED HILL, OR
114 TONY GROVE LAKE, UT
115 NORTH FRENCH CREEK, WY
116 CALVERT CREEK, MT
117 GREENPOINT, OR
118 DILL'S CAMP, UT
119 SOUTH BRUSH CREEK, WY
120 BLACK BEAR, MT
121 FOURMILE LAKE, OR
122 TROUT CREEK, UT
123 LICK CREEK, MT
124 SILVIES, OR
125 CLEAR CREEK RIDGE, UT
126 SHOWER FALLS, MT
127 LUCKY STRIKE, OR
128 KING'S CABIN, UT
129 N FK ELK CREEK, MT
130 LAKE CREEK R.S., OR
131 MOSBY MTN., UT
132 COPPER BOTTOM, MT
133 CHAMPION, OR
134 RED PINE RIDGE, UT
135 COPPER CAMP, MT
136 JUMP OFF JOE, OR
137 INDIAN CANYON, UT
138 ROCKER PEAK, MT
139 TIPTON, OR
140 SEELEY CREEK, UT
141 FROHNER MEADOW, MT
142 BUCK FLAT, UT
143 FISHER CREEK, MT
144 VERNON CREEK, UT
145 SILVER RUN, MT
146 CLEAR CREEK RIDGE #2, UT
147 STAHL PEAK, MT
148 WHITE RIVER #1, UT
149 GRAVE CREEK, MT
150 BROWN DUCK RIDGE, UT
151 MAVERICK FORK, AZ
152 MCNARY, AZ
153 UPPER SAN JUAN, CO
154 MINERAL CREEK, CO
155 CASCADE, CO
156 MORSE LAKE, WA
157 BIG BOULDER CREEK, WA
158 GRAHAM GUARD STA., ID
159 TEX CREEK, ID
160 SHEEP MTN., ID

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Figure 5
SNOTEL SITES
WESTERN UNITED STATES

JANUARY 1978

50 0 50 100 150 MILES
SCALE 1:12,500,000

Source:
Base map prepared by SCS, WTSC Carto Staff from USGS, Water Resource Development, May 1969.
Thematic detail prepared by Water Supply Forecast Staff.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1978

New designs in snow sensors and associated equipment are being tested and added to the system. This ongoing testing during the initial installation is a testimonial to flexibility and effectiveness of the SNOTEL system design.

Summary

The SNOTEL system is a new hydrometeorological data-collection system designed to collect data from widely scattered remote sites in mountainous terrain. It is an automated system for gathering snowpack information to be used in providing more timely and reliable estimates of snowpack runoff in the water-short Western United States. The SNOTEL system uses the latest advances in sensor technology, communications engineering, digital electronics, and data processing to provide a broad community of users with a planning and operations tool for improved water management.

The SNOTEL system is designed to be used in conjunction with the present network of manually measured snow courses. It will complement the manual surveys in the foreseeable future, but it will not replace them.

Although the SNOTEL program is designed specifically to aid in forecasting water supplies affecting more than 10 million acres of irrigated land, it can and will be used for a multitude of other purposes. Officials responsible for flood control, municipal water supply, reservoir management, recreation, power generation, fish and wildlife management, and industry will have one more tool at their disposal to help them with their decisions.

As competition grows for increasingly limited amounts of water, it is imperative that we take advantage of every available means to distribute wisely the resources we possess. If a meteor hurtling from another galaxy millions of light years away can tell us how much snow we have in our mountain reservoirs, then we should take heed and plan accordingly.

WATER DATA ACTIVITIES OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

By Harold S. Lippmann[1/]

The National Oceanic and Atmospheric Administration (NOAA), the largest agency in the U.S. Department of Commerce, was formed in a 1970 reorganization. It incorporated old-line agencies, such as the Weather Bureau, the Coast and Geodetic Survey, and the Bureau of Commercial Fisheries, and elements from other agencies, such as the National Bureau of Standards' Wage Propagation Laboratory, and emerged like a phoenix from the ashes of the Environmental Science Services Administration. NOAA's mission is to improve man's comprehension and uses of the physical environment and its oceanic life. As such, many of NOAA's programs are water-oriented, although far more are directed to the marine environment than to the area of interest to NAWDEX: our streams and lakes, and the estuaries of our coastlines. This paper will review the water-data activities of NOAA that are related to NAWDEX.

By way of orientation, let us first consider the present distribution of operating elements in NOAA, highlighting those projects that are NAWDEX-related (fig. 1).

The National Ocean Survey (NOS) prepares aeronautical charts, conducts precise geodetic and oceanographic surveys, records and predicts tides and currents, and prepares and publishes navigational charts and related materials for coastal waters and the Great Lakes.

The National Weather Service (NWS) reports the weather of the United States and possessions, provides weather forecasts to the general public, issues warnings against tornadoes, hurricanes, floods, tsunamis, and other atmospheric and hydrologic hazards, and provides a broad array of special services to weather-sensitive activities. These services are supported by an increasingly automated national network of data collecting facilities.

The National Marine Fisheries Service (NMFS) seeks to discover, describe, develop, and conserve the living resources of the global sea, especially as these affect the American economy and diet. It studies estuarine organisms in their geological relationship with game fish.

The Environmental Research Laboratories (ERL) are concerned with conducting the fundamental investigation needed to improve man's understanding of the physical environment. Although much of ERL's effort is marine-oriented, and significant research is directed toward such water-related activities as weather modification, severe local storms, hurricanes, and basic atmospheric

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National Oceanic and Atmospheric Administration

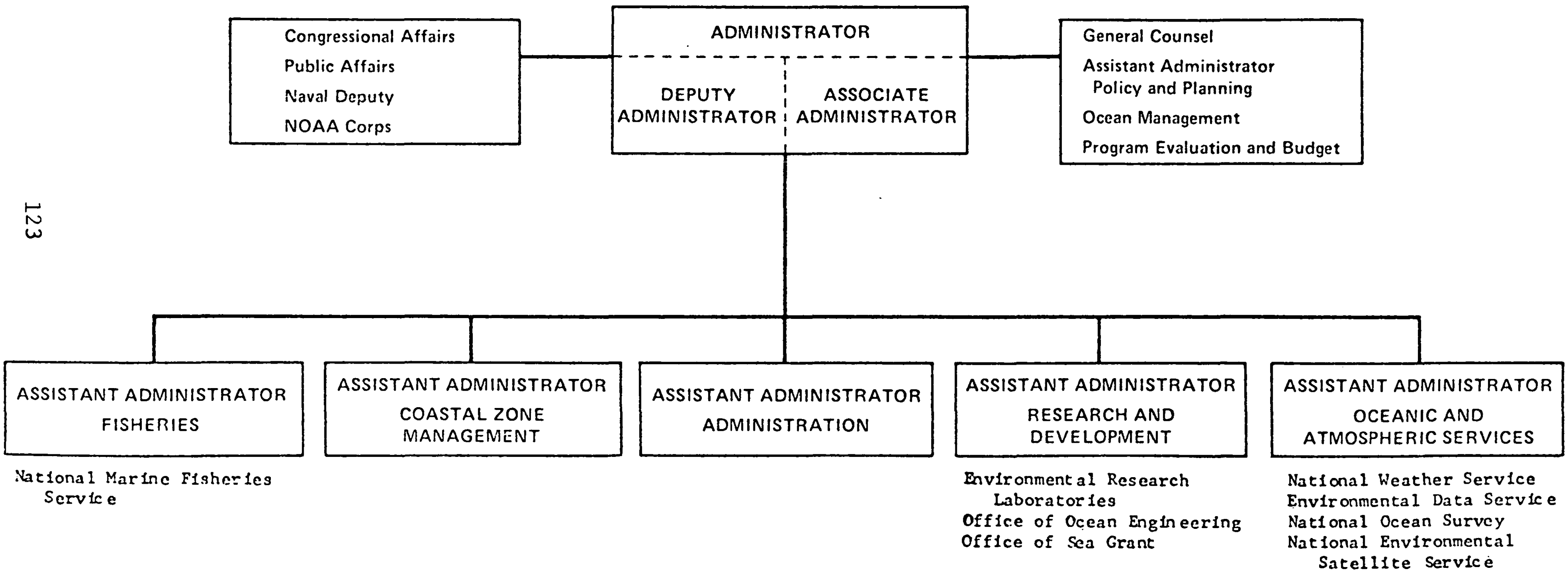

Figure 1.- Organization of the National Oceanic and Atmospheric Administration. (Offices under the Assistant Administrator for Administration not shown.)

processes, it does not have a discernable role in the water data activities with which NAWDEX is concerned.

The National Environmental Satellite Service (NESS) operates the Nation's environmental satellite system and insures that the masses of data acquired thereby flow in useful form to those who need them. The Geostationary Operational Environmental Satellite (GOES) data collection system is of great importance in the transmission of water data in real-time.

The Environmental Data Service acquires, processes, and disseminates global environmental data and information. Its important water data-related projects will be described in another paper.

The Office of Sea Grant administers and directs the National Sea Grant Program. This program provides support for institutions engaged in comprehensive marine research, education, and advisory service programs. Since its scope is directed almost exclusively to the marine environment, it is not considered NAWDEX-oriented.

The Office of Coastal Zone Management carries out NOAA's responsibilities under the Coastal Zone Management Act of 1972. NOAA provides funds to aid states in developing and carrying out comprehensive programs for managing their coastal zones. The Office of Coastal Zone Management also provides grants to establish estuarine sanctuaries. This NOAA element neither collects nor disseminates water data of interest to NAWDEX.

Now let us discuss the NAWDEX-applicable projects further: NOS projects of interest to NAWDEX are the operation of the U.S. portion of the network of stations that measure the water levels on the Great Lakes, and the tide gaging stations on the estuaries. There are 54 permanent lake level stations of NOS on the Great Lakes. This network is augmented by additional "seasonal" stations, operated for varying periods of time from a few months to a few years. The network is being automated, the data are collected by NOS, processed at NOS headquarters in Rockville, Maryland, and are disseminated on request. Approximately 100 of the NOS tide gaging stations are permanent installations in the estuaries. This network, also, is supplemented by "seasonal" stations operated for periods of less than 30 days to a year or more. These data, also, are made available by the NOS on request.

NMFS collects data on landings by fishermen and vessels separately for each of the Great Lakes, and by states for the Mississippi River fisheries. These data are also analyzed by species and by fishing gear used. The data are published in the annual "Fishery Statistics of the United States."

The GOES data collection system of NESS relays water data and water-related data from 292 locations to the organizations that installed the data collection platforms. The Corps of Engineers, U.S. Geological Survey, and NWS are the principal participating agencies. All of these data are made available to

NWS in real-time for use in the river forecasting program. In addition, NESS measures snow cover from the visual products of polar-orbiting satellites, and studies the hydrologic application of these and other NESS-obtained data.

The National Weather Service's water data and water-related data activities are, in a sense, typical of a NAWDEX member agency. NWS collects water stage data, lake and reservoir level data, and dam discharge data from 2502 stations daily, and from another 1014 stations when criteria are reached or exceeded. These data, together with precipitation data from 3274 that report daily, and another 4029 that report when criteria are reached or exceeded, are forwarded to 12 NWS regional River Forecast Centers where river and flood forecasts for approximately 2500 communities are prepared (fig. 2). Some of the precipitation-reporting stations also report river stage, and are included in both sets of station counts. Reporting stations in Hawaii, Puerto Rico, and the U.S. Virgin Islands are included in the counts, but these areas are not served by River Forecast Centers (RFC's).

Included in the flood forecasts are the height of the flood crest as well as the times when the river is expected to overflow its banks and when it will recede within its banks. At many points, particularly along larger streams, daily forecasts of river stage and/or discharge are routinely prepared for use by those interested in navigation, power generation, and water management. Reservoir inflow forecasts aid Federal, State, and local agencies in the operation of these reservoirs in their water management activities. Forecasts of ice formation and breakup and of water temperature are prepared for a limited number of locations.

Flash flooding has become one of the most lethal of the natural disasters of the United States. Timely warnings of flash floods are dependent upon data automation and good communications. NWS has developed several methods to cope with these dangerous situations, any one or a combination of which may be used in a particular community:

1. General flash flood watches and warnings for the communities in an area, distributed by NWS offices.
2. Specific flash flood watches and warnings provided by a NWS office for a community with chronic flood problems.
3. Community self-help stage forecast programs. The NWS assists in setting up the necessary data network; develops precomputed flood forecasting relations; and trains the authorized community representatives in their use.
4. Stage forecasts made my a nearby NWS office if the necessary data network can be automated.
5. Installation of Flash Flood Alarm Systems. These are essentially stream gages that send an alarm signal to the community when the stream reaches a critical level.

Automation of data collection in the NWS has advanced to the point that 432 hydrologic stations respond to a telephone call placed by a computer with

Figure 2.--National Weather Service Forecast Office/National Weather Service Office Hydrologic Service Areas.

either the accumulated precipitation, the river stage, or both. The computer collects the data either on a programmed schedule or on request by appropriate NWS offices, and assembles the reports and forwards them to the office that requested them. Another 55 stations report through the GOES satellite, half of them on a self-timed basis, and the rest when requested by the control station operated by NESS. In addition to these, about 500 stations are telemetered, but not automated.

However, only about 10 percent of the stations that report river stage to the NWS are entirely the property of the NWS. Ownership of almost all the rest is rather evenly divided between the U.S. Geological Survey and the U.S. Corps of Engineers. Ownership of the remainder is scattered among several agencies.

At stations that are neither telemetered nor automated, the NWS recruits an observer to make one observation a day, to record this on a manuscript form, and to report by telephone to a designated NWS office either daily or when criteria are exceeded, and then at 6-hourly intervals. The manuscript records are forwarded monthly to the EDS National Climatic Center for processing and archiving. Records containing precipitation and other hydrometeorological data are processed as climatic data, and are included in the EDS publications "Climatological Data" and "Hourly Precipitation Data." Peak stage data for NWS river gages are published in the annual "River Forecasts Provided by the National Weather Service." Observed data from NWS stations are available from the National Climatic Center for the cost of copying.

Forecasts of seasonal snowmelt or water-year runoff are prepared monthly from January through May in the West by RFC's that serve in that area, and from April through September for Alaska by the Anchorage, Alaska, RFC. Forecasts of seasonal snowmelt and monthly runoff are prepared monthly in the Northeast by the RFC's at Bloomfield, Connecticut, and Harrisburg, Pennsylvania. These water supply forecasts for 600 points, where snow is the principal source of streamflow, are distributed monthly to water users by local NWS offices. They are also available in the NWS publications, "Water Supply Outlook for the Western United States," "Water Supply Outlook for the Northeastern United States," and "Water Supply Outlook for the State of Alaska."

The National Oceanic and Atmospheric Administration is proud to have participated in the studies that led to the establishment of NAWDEX, and to have become one of the first members of NAWDEX. We of NOAA expect not only to provide data through NAWDEX, but also to draw on NAWDEX for data of other organizations. We wish NAWDEX well, and salute NAWDEX and its parent organization, the U.S. Geological Survey, on the occasion of this, its first membership meeting.

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AN OVERVIEW OF THE NOAA ENVIRONMENTAL DATA SERVICE

By Robert R. Freeman[1/]

The Environmental Data Service (EDS)* is part of the National Oceanic and Atmospheric Administration. Each of our centers and programs is listed in the new directory of "Federal Environmental Data Sources" published recently by the National Science Foundation. One other source of information on the Environmental Data Service is the article in the NAWDEX Newsletter, November 1977, which gives descriptions and points of contact with each of our centers.

The Environmental Data Service was one of the first attempts by the Federal Government to organize multidisciplinary data in the areas of rising national interests in the natural environment. It was created in 1966. Its history goes back even before that in activities that had been conducted in the Weather Bureau and other agencies, prior to the consolidation that Harold Lippmann described.

In the Environmental Data Service we attempt to cope with some of the problems described here of handling multidisciplinary data within the context of a single overall organization, and we do this be operating six data and information centers, attempting to provide a one-stop information and data service covering information on the oceans, the atmosphere, the solid earth, and the solar environment. By "one-stop" we simply mean that a call or request directed to any of our centers, even though it may be answered best by calling on the resources of several of the centers, can be answered just through that one point of contact with any of the centers.

Our business in EDS is providing service on request and we do that currently at the rate of about 90,000 requests per year. In addition to answering requests that are directed to us, our centers issue publications on a subscription basis, many of them available through the Government Printing Office.

The largest of the Environmental Data Service centers, and probably the one that is of greatest interest to the water data community, is the National Climatic Center (NCC). It is located in Asheville, North Carolina. It is probably one of the largest scientific data centers any place. It archives and makes available a constantly growing amount of climatological information originating from national meteorological programs.

Of special interest to the water data and information community is the precipitation data available from NCC. NCC regularly collected data from the

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*Note.--This name was changed to Environmental Data and Information Service (EDIS) in July 1978.

300 first-order stations of the National Weather Service, from the military weather service stations, from the U.S. Coast Guard, the FAA, and from 12,000 cooperative observers, who daily report the amount of precipitation in the past 24 hours.

The National Climatic Center also publishes a series of data bulletins called "Hourly Precipitation Data," to which some of the other speakers have referred--one for each state and, in a few cases, collections or groups of states. In addition, there is an annual publication known as "River Forecasts Provided by the National Weather Service" published by the NCC.

Since 1973, 40 states have established programs to acquire and analyze climatic data and provide climatic services. These state climatology programs are generally located at state universities or agricultural experiment stations, and the state climatologists there are familiar with the products and services of the National Climatic Center and can assist local users in accessing the NCC.

As we have just last week observed the first national "Sun-Day," I will also mention that other forms of climatological data, including cloud cover, solar radiation, and wind direction and wind speed data find application in planning for solar power development.

Another of our centers--the closest geographically to where we are now--is the National Geophysical and Solar-Terrestrial Data Center (NGSDC). It is located in Boulder, Colorado. The NGSDC specializes in three distinct environments: the solar-terrestrial relationship, the solid earth, and marine geology and geophysics. Of special interest, I think, to engineers working in the water resources community are the seismological records available through NGSDC. The NGSDC also has been working with a multiagency effort to develop a natural hazards data and information service.

A third data center in the Environmental Data Service is the National Oceanographic Data Center (NODC). It is the major national center and the largest in the world for unclassified oceanographic data. At the present time, NODC is actively involved in providing interdisciplinary data products and services for national programs such as the Alaskan outer continental shelf oil exploration.

Going on to a different kind of center now, in the last two years the Environmental Data Service has begun to develop new services based on assessments, or special analyses of its data for national policy problems. As a vehicle for this work, two new units have been created. One of these is the Center for Climatic and Environmental Assessment (CCEA). It has its headquarters in Columbia, Missouri, and another portion of it is located in Washington, D.C.

CCEA has specialized in estimating the probabilities of yields of important grain crops based on models, climatological and crop-yield data, and current weather observations. Some of this activity is carried on as a joint program with the U.S. Department of Agriculture and the National Aeronautics and Space Administration (NASA).

Maps dealing with precipitation shortages and excesses have proven to be a useful output of this type of program. The CCEA is also responsible for publishing the very popular Weekly Weather and Crop Bulletin which goes directly to many people in the farming community.

Another type of assessment effort by the Environmental Data Service is carried out by the Marine Assessment Division of the Center for Experiment, Design and Data Analysis (CEDDA). This division has made studies of the fate of oil dumped into the ocean as a result of tanker accidents and it has also provided studies of the potential impact of alternative locations of deepwater ports.

CEDDA has, as its major responsibility, the planning and carrying out of data management activities of some of the recent large-scale scientific experiments that are aimed at fundamental understanding of the circulation of the oceans and the atmosphere. These included BOMEX--the Barbados Oceanographic and Meteorological Experiment, the International Field Year for the Great Lakes, and GATE, the GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment.

The last EDS center is the Environmental Science Information Center (ESIC). ESIC is responsible for a range of services based on published information. This includes operating library and information service facilities for NOAA in the Washington, D.C. area and in Miami, and providing editorial and publishing services for most NOAA components.

In addition to the various direct data and information archiving and service facilities, we also have two important referral services. One of these is known as ENDEX for the Environmental Data Index, and the other is OASIS, the Oceanic and Atmospheric Scientific Information System.

ENDEX is directed in a very similar fashion toward NAWDEX, I think, towards descriptions of data collection effort, detailed inventories of data collection efforts, and probably primarily toward data file descriptions. These have been built by surveying directly around the country--state-by-state--looking for collections of environmental data of the types that EDS is most concerned with. ENDEX now contains on the order of 1,100 descriptions of environmental data files, and the effort is still going on.

OASIS, on the other hand, is directed toward access to published information. In addition, our OASIS program has sponsored the creation

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NOTE: In July 1978 CCEA and CEDDA were merged to form the Center for Environmental Assessment Services (CEAS).

and establishment of several bibliographic data bases. The major ones are Oceanic Abstracts, Meteorological Abstracts, and Aquatic Sciences and Fisheries Abstracts. These have now been made available through a contract with the Lockheed Corporation for nationwide access. Searches of the data bases are also available through our EDS Data and Information Centers.

A new program which we have just launched recently in conjunction with the National Sea Grant Program and the Office of Coastal Zone Management of NOAA is known as the Regional Coastal Information Centers Program. The Regional Coastal Information Centers are intended to improve the accessibility of information related to the very complex questions of coastal zone management.

We hope the establishment of this new program of coastal information centers will assist us in coping with some of the problems generated by the rather large number of Federal programs that have come along in the last few years. These programs require the States to collect data and information and make the best possible use of them in decisionmaking within the States with regard to coastal zone management and other policy matters which relate to the coastal zone of the States.

The information in this area is very complex, diverse, and unorganized, and through these coastal information centers we hope to try to improve access and referral to this type of information.

There are now three, out of an eventual nine, coastal information centers that have been established. The ones that are in operation are serving the Northeast, located at the University of Rhode Island; the Pacific Northwest, located partially at the University of Washington and partially at the Oregon State University; and now, just recently, the Great Lakes region, operated jointly by the University of Michigan and the Great Lakes Basin Commission.

An international program which we are increasingly involved in is the Aquatic Sciences and Fisheries Information System (ASFIS). It has as its goals, on a worldwide basis, collecting and disseminating published information on the marine and freshwater environments and ecosystems, and also through the means of disseminating published information to facilitate technology transfer, particularly to the developing nations.

Incidentally, in the ASFIS, we try very hard to make a clear borderline in the area of water resources so that we do not duplicate the work that is going on in the Water Resources Scientific Information Center.

The ASFIS is organized under the auspices of the Food and Agriculture Organization of the United Nations, the Intergovernmental Oceanographic Commission of UNESCO, and the Ocean Economics and Technology Office of the United Nations Headquarters in New York. There are now input centers and service centers in six countries, including the United States.

The products and services of this new system consist of the various items that you see here. There is an abstract journal which contains a good deal of information, I believe, that would be of interest to the water data community called "Aquatic Sciences and Fisheries Abstracts." We have the beginnings of a bibliographic data base which will be accessible through an on-line system. Other publications include the World List of Marine and Freshwater Serials and the monthly Marine Science Contents Tables.

I thank you very much for an opportunity to describe to you the products and services of the Environmental Data Service.

WATER RESOURCES SCIENTIFIC INFORMATION CENTER (WRSIC)

by Raymond A. Jensen[1]

The Water Resources Scientific Information Center (WRSIC) is located in the Office of Water Research and Technology, Department of the Interior. It was initially authorized by the 1964 Water Resources Research Act. To provide a brief historical note, the Interagency Committee on Water Resources Research recommended in 1965 that there be such an information center and that it be located in the Department of the Interior. In January 1966, the Secretary of the Interior placed it in what was then the Office of Water Resources Research (OWRR). In December 1966, the President's Science Advisor designated it as the national center for scientific and technical information in water resources.

OWRR was combined with the Office of Saline Water (OSW) in 1974 to form the current Office of Water Research and Technology, (OWRT). Presently, since both OSW's and OWRT's legislation, at least partially, has lapsed, we are seeking new organic legislation and, as of this point last week, markups were completed in both the House and the Senate. Until they have a conference we won't know what our new legislation looks like, but it does appear to designate us, more clearly than in the original act, as the National Center.

As an information center, we have two major information bases. One comprises published documents and the other one, which I will discuss later, comprises notices of research in progress. The major data base is depicted as a pie chart, in terms of input; 78 percent of all input that comes to us comes into our centers of competence. The total pie chart represents about 13,000 to 14,000 processed documents each year.

When we started, we were told not to duplicate any work or organization's efforts that paralleled our own. We learned that many research centers, particularly universities, were exploring the literature already to support their own research program. We asked these agencies or research centers to use our vocabulary and our standards for citation, and, in return, we will pay the incremental cost of providing input into our center. This has progressed well. We have about 13 or 14 input centers of competence located, generally, in universities around the country, and in addition, we have about three that are supported by the U.S. Environmental Protection Agency.

Our next largest sources of input are both State institutes and government agencies which produce 13 percent of our input. The WRSIC program in OWRT funds 54 State Water Resources Research Institutes, generally located at land grant universities. These institutes abstract and

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index their own documents and provide them to us. We have similar service agreements with government agencies to provide our products and services in exchange for their documents, abstracted and indexed in our format. Similar agreements exist with Canada, Australia, and South Africa, and that produces an additional 4 percent of our input. We have an arrangement, also, with Biological Abstracts whereby they search their output monthly for non-English-language materials in water resources. At the end of this year, we will phase out this particular agreement because we are not getting much additional informtion.

The project file was previously displayed in what was called the Water Resources Research Catalog. We published the 11th edition last year. Because a catalog product is a year late plus another 6-month delay in producing it, we decided to stop publishing and rely primarily on our online search systems. There are about 15,000 projects in the file, which is updated every 3 months, and which is computer searchable.

Our online system is the Recon system supported by the Department of Energy. It is a network of both hard-wired and dial-up terminals. The abstract files can be searched by title, author, institution, descriptors, COWRR categories and the abstract. The project file, which is being loaded on Recon right now, is searchable by all these items except for the COWRR categories, which have not been assigned by the agencies contributing the data.

The Recon network consists of five dedicated lines (hard-wired terminals), which are accessible all day. In addition, there are 12 dial-up terminals, as well as two additional pending installations. There are two foreign depositories also in the Recon network, and our tapes go to Canada and to Australia where they have their own search software programs operating. Our central processor is at Oak Ridge, Tenn. Where possible, and when the central processor has the capacity, we install terminals using dedicated lines. The reason we don't have more nodes at the State institutes is that the computer at the Department of Energy is somewhat bound by the limitations of capacity. If they expand their capacity, we will probably expand the number of searching nodes in the network.

Topical bibliographies are products of the data base. Some of the titles have become reoccurring and have been published in 3, 4, or 5 volumes. Algae Abstracts is somewhat different. It is published by a commercial publisher, Plenum Press. The others are published by WRSIC. Topical bibliographies probably will convert into some selective dissemination system, and cause the abandonment of the general abstracting journal.

Some of our centers of competence really are information analysis centers and have the ability and the expertise to do state-of-the-art or state-of-the-technology reviews. Examples of some recent ones are "The Winters Doctrine", published within the past few months, and "Water Well Technology" which was published by McGraw Hill several years ago. WRSIC plans eventually to upgrade all centers of competence to information analysis centers and to compress the literature somewhat by doing more state-of-the-art studies and reviews.

There are three essential publications (guides) that WRSIC centers use. They are: (1) Water Resources Thesaurus--second edition; (2) Abstracting and Indexing Guide; and (3) Searching Water Resources Literature by Computer. We are considering a new thesaurus built around our Recon subject index. It should be noted that some NAWDEX Local Assistance Centers have WRSIC terminals--Illinois, Tucson, Austin, Jackson, Raleigh, Blacksburg and Boston. Again, growth in this combined activity depends on computer capacity limitations. This combined system may well grow fairly extensively.

We also have an offline search system called "GYPSY". The people here from the Geological Survey are more familiar with this search system than others. This system produces the bibliographies mentioned earlier. It has a text searching capability that can search title, author, institutions, sponsor, descriptors, categories, abstracts, citation, fiscal year and, in the case of projects, fiscal year starting date and ending date, country, and the funding, and it goes beyond that. You can get the mean, the mode and the average amount of money spent on the projects searched and identified.

Some recent statistics on data-base use in the search system show that in 1976, about 47 terminals were accessing the Recon system. There are now around 150, of which about 50 use the Selected Water Resources Abstracts, our data base. The system has had 13 to 20 data bases, a fairly constant number, of which ours has generated about 24 percent of system use. We are currently printing about 32,000 abstracts using Recon. We can't translate those abstracts into the number of computer searches. The computer doesn't count the number of times you use it to do a search. It only counts the number of abstracts that are reprinted, and we don't have a reasonable method of conversion. But we find that as the system expands, our part has expanded at about the same rate.

WATER DATA AND THE NORTH DAKOTA REGIONAL ENVIRONMENTAL ASSESSMENT PROGRAM

By John R. Reid[1/] and Richard V. Giddings[2/]

INTRODUCTION

Mining of lignite coal in North Dakota presumably has occurred since it was first discovered to be of value. During most of this time, use of the coal has been restricted largely to heating homes and industrial plants, but in 1927 the first lignite-fired electric generating plant in North Dakota became operational in Beulah, generating 2.5 megawatts of elecricity (Montana-Dakota Utility Company records). By 1938 there were over 300 coal mines operating in North Dakota, most of them underground (State Planning Board, 1938). Today, there are six major lignite power generating plants operating in North Dakota capable of producing 1600 megawatts of electricity, most for export to other States. The need for North Dakota electricity increased only gradually until the early 1970's when it became evident the pending energy crisis would require a significant increase in the use of coal resources. Many citizens of the State became alarmed; they feared Washington bureaucrats or eastern industrial concerns soon would be dictating the development of North Dakota. If the citizens were to have the control that they deemed to be their right, they would have to have an accurate and coordinated forecasting system so that appropriate decisions could be made by the decisionmakers. (It appears the same kind of threat presently exists with regard to North Dakota water rights.)

The idea for such a capability in North Dakota arose in 1974 when the North Dakota Legislative Council contracted with Battelle's Columbus Laboratories to conceptualize such a comprehensive system. Battelle prepared and presented to the Resources Development Committee of the Legislative Council a report suggesting the design and structure for a "regional environmental assessment program" (Battelle, 1975). In October 1974, the concept was approved by that committee, and in November a draft bill was prepared. House Bill 1004 was adopted by the legislature and on April 10, 1975, Governor Arthur Link signed it into law establishing the North Dakota Regional Environmental Assessment Program (REAP) and providing an appropriation of $2 million from a special coal severance tax trust fund.

House Bill 1004 provided two mandates for REAP: "to carry on research in regard to North Dakota's resources [and] . . . to develop the necessary data and information systems." The stated purposes were to assist "in the development of new laws, policies, and governmental actions . . . [and to provide] facts and information to the citizens of the State . . . [in order that they may know] the alternatives available to the State in any use and development of resources . . . [and so that they will know] the results and impacts of any such use or development." The REAP staff, consisting of a director, two associate directors, and a secretary, was charged with defining

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what the REAP system should be, without being able to rely on the experience of efforts by other States; no other State had attempted to develop such a system before. It was decided to concentrate efforts on the southwestern part of North Dakota, the area of most intensive development impact.

Design Process:

The first task during the summer and fall of 1975 was to identify the experts in the State, determine the existence of data relevant to environment and socioeconomics for North Dakota, and determine what types of information still were needed. Once the experts were identified, they were invited to participate in a series of task forces. As a result, 92 technical experts from State universities, State agencies, Federal agencies, and local government participated in a series of 11 Technical Task Forces (TTF's). These TTF's included air quality-meteorology, geology, historic-archaeologic-paleontologic sites, land use, social impact-quality of life, socioeconomic impact and projection modeling, soils, vegetation, water, and noise-radiation-solid waste. Each identified existing data and data not presently available but needed, recommended a methodology for collecting new data, recommended the format and system by which the data should be stored and retrieved, identified organizations and persons qualified to participate in a data acquisition effort, what future monitoring was needed, and the appropriate models to be used for projecting change (REAP, 1975). Perhaps the most important result of the TTF's was the recommendations for priority baseline data acquisition studies. From these, REAP issued Requests for Proposals to undertake the acquisition of the priority data for the State of North Dakota. Proposals were received from all over the United States; these were then sent to experts throughout North America for their review and recommendations. Contracts (table 1) were eventually awarded to those investigators who demonstrated capabilities to collect and assess the data in the most cost effective manner. In every case, the contract stipulated that the investigator be required to submit a detailed bibliography for that project, undertake the acquisition of new data within a restricted time limit, and relate the results of the research to previously existing studies in North Dakota. Draft final reports were required to be received one month prior to the termination of the contract. These draft reports were reviewed by experts, and changes were required in the final report before the final payment of the contract was authorized. As the final reports were received, they were published as REAP reports.

Concurrently with the activity of the Technical Task Forces was an effort to assess the complete REAP system concept. For this purpose, International Business Machines/Federal Systems Division of Gaithersburg, Maryland (IBM), was contracted to define the system requirements and to provide the conceptual design of what the REAP system should be. This report was completed December 1975 (IBM, 1975). As part of that contract, several interim capabilities were defined. These capabilities included the development of a REAP Resource Reference System (R^3S) and an Economic-Demographic (E-D) Model, both of which will be discussed later.

TABLE 1. REAP DATA BASE CONTRACTS
1976 - 1978

AIR QUALITY METEOROLOGY:

Evaluation of meteorological sites in southwestern North Dakota -- North Dakota State University ($57,000)

North Dakota Regional Environmental Assessment Program Air Quality Network -- North Dakota Department of Health ($180,000)

BIOLOGY:
Botany:

Grasslands and wetlands of southwestern North Dakota --North Dakota State University ($77,000)

Woodlands, shrubs and algae of southwestern North Dakota -- University of North Dakota ($79,700)

ZOOLOGY:

Aquatic mullusks of southwestern North Dakota -- University of North Dakota ($7,400)

Arthropods of southwestern North Dakota -- North Dakota State University ($40,000)

Fishes of southwestern North Dakota -- University of North Dakota ($29,000)

Land mullusks of southwestern North Dakota -- Minot State College ($5,500)

Soil fauna and parasites of southwestern North Dakota -- University of North Dakota ($35,000)

Vertebrates of southwestern North Dakota -- University of North Dakota ($85,000)

GEOLOGY:

Geology and hydrogeology of the Knife River Basin -- North Dakota Geological Survey ($132,000)

LAND COVER:

Land cover of North Dakota -- Bendix Aerospace Systems Division ($145,553)

SITES:

Archaeologic sites in North Dakota -- University of North Dakota ($7,900)

Historic sites in North Dakota -- University of North Dakota ($16,200)

Paleontologic sites in North Dakota -- University of North Dakota ($7,100)

SOCIOECONOMIC:

Longitudinal socioeconomic data in western North Dakota -- University of North Dakota/North Dakota State University ($199,800)

WATER:

Water resources and model conceptualization of the Knife River Basin -- North Dakota State Water Commission ($47,000)

Once the REAP staff was confident that IBM had adequately defined an appropriate concept for the design of the REAP system, they entered into a second contract with IBM to provide two additional reports--a high level system design, and a plan for implementation (IBM, 1976a, b). The major responsibility for the first part of the system design rested with the REAP staff, with IBM support. The approach taken was to form a series of 10 REAP User Specification Teams (RUSTEAMS) comprised of 53 technical experts drawn from expected users of REAP (31 from State agencies, 6 from Federal agencies, 12 from universities, 1 from industry, and 3 from local government). The RUSTEAMS were organized by discipline (air quality-meteorology, animals, geology, historic-archaeologic-paleontologic sites, land use, social impact, socioeconomic impact, soils, vegetation, and water). Each team met for two 2-day working sessions and were expected to complete additional homework assignments. To aid users with little or no computer experience in specifying system requirements, users were encouraged to visualize system output reports in any format they desired. From that point they elaborated the input data requirements, output report contents, and the processing, analysis, and modeling requirements for the support of such reports. The results of the RUSTEAM efforts were evaluated, summarized, and prioritized by the REAP staff. The conclusions of the entire effort were published in the Systems Analysis Details report (IBM, 1976a). This high level of detail was required to serve as a basis for REAP system design efforts which followed.

On the basis of that report, IBM assumed the major responsibility for the second task, the design of the system architecture necessary to provide the desired capabilities and the formulation of a plan which included a time schedule and cost of implementation of a REAP system. This report, Systems Analysis and Plan report, was completed in October 1976 (IBM, 1976b). This report was then evaluated by the REAP staff and, along with an alternative approach, was presented to REAP's board of directors, the Legislative Council's Resources Research Committee.

PRESENT STATUS

R^3S:

The REAP Resource Reference System (R^3S) was one of the first capabilities developed by REAP. It was in response to the concern expressed by both citizens and decisionmakers that researchers were literally bumping into one another in the coal impact areas, often repeating work that others had already accomplished a short time before. "If only REAP could keep track of who was doing what," they said. R^3S, REAP's attempt to address this concern, includes four separate files--Projects, People, Data Sources, and Bibliography. The initial contents were based upon data provided by the Technical Task Forces. This capability has been operational since January 1977. The Project File now contains 623 documents. This file contains all current studies on the REAP-related areas in North Dakota. Included is the project title, sources of funding, goals, the location of the study, the expected date of completion, and the principal investigators.

The second file, People, is a convenient compendium of North Dakota technical experts who are doing or have accomplished REAP-related research on North Dakota. It also includes other North Dakotans who have demonstrated unusual expertise in a field relevant to REAP or who are contact persons for State or Federal agencies, businesses, or industries which have the authority to sponsor or conduct REAP-related projects. This file now contains 543 documents.

The Data Source File contains descriptions of data collections relevant to REAP. Many of these data sources are Federal repositories, such as Reston, Virginia; Ames, Iowa; Lincoln, Nebraska; and Austin, Texas. The file lists the type and availability of data and the contact person for the data. The reason for including this file was the understanding that the ultimate REAP system would not reproduce these data but merely make the data more accessible. There are currently 140 documents included in this file.

The fourth file, Bibliography, which at the present time contains 9,404 documents, has been the most useful. This file includes all REAP-related published and unpublished papers, reports, books, articles, and manuscripts which contain information, projections, or analyses about North Dakota. Entries include the keyword abstracts and reference citation.

The uniqueness of the R^3S is that it is a computer-bases online interactive information system with a text-search capability. This means that all words in the title or the abstract automatically become keywords for an R^3S search.

E-D Model:

The second capability, developed while the rest of the REAP system was being defined and planned, was the Economic-Demographic (E-D) Model. The contract for the model design was awarded to an inter-institutional social science team from North Dakota State University and the University of North Dakota, while the model implementation contract was awarded to Arthur D. Little, Inc., of Cambridge, Massachusetts. The purpose of the E-D Model was to allow predictions of the economic and demographic consequences resulting from major resource development projects. The emphasis of the model was on impacts of coal development projects. It was, therefore, restricted to the southwestern 15 counties of North Dakota. The model actually consisted of four submodels: an input-output economic model capable of forecasting levels of business volume, employment, and personal income; a cohort-survival submodel capable of forecasting population by age and sex, as well as total population; a submodel, which was a merger of the first two submodels, to provide for balancing the supply and demand for labor; and a fiscal impact model to provide the capability of projecting public sector costs and public sector revenues by type, and net fiscal balance for the State and for local governmental units (REAP, 1977a, b). The model was designed to be user interactive, providing the capability for changing many of the assumptions on which the model was based. Although this model was intended to be a test model, it proved to be so successful that a new model is being developed for the entire State, expanding on the types of developments for which projections can be made. So far, the first model has been widely used for planning, for school expenditures, for school expansions, highway planning, water system development, determining whether a TV station should be constructed, and many other uses. Subsequent to the development of the initial model, special censuses have demonstrated the accuracy of that model in projecting populations.

Land Cover Analysis:

In order to measure changes in the land surface of North Dakota, REAP awarded a contract to Bendix Aerospace Systems Division of Ann Arbor, Michigan, to produce a land cover analysis of North Dakota. Using imagery collected largely by Landsat II, launched January 1975, but with some minor imagery from Landsat I, launched July 1972, Bendix processed the data by computer. Ground information was collected by a subcontracting team from the Institute for Remote Sensing at the University of North Dakota. The computer was trained to identify all areas having similar combinations of reflectivities from the four spectral wavelength bands on the satellite. The products of the contract included a 10-color map of each of the 53 counties of North Dakota showing the dominant land cover for every 1.1-acre cell at a scale of 2 miles to the inch. A mosaic of each of the counties was prepared to make a map of the entire State at a scale of about 8 miles to the inch. Of more importance, however, were some of the other products. These included the digitized tape of the dominant land cover for each 1.1-acre unit of the State, and another tape in which the detailed land cover data were merged with a digital file of the sections in the State aggregating the dominant land cover for every quarter-quarter section. Subsequently, another tape has been developed providing the dominant land cover for each of the drainage basins in the State. These land cover tapes will allow REAP to identify the dominant cover for any polygon in the State, whether it be a transmission line corridor or a planning district. Correction of urban areas, not readily discerned by satellite, and miscategorized areas, such as those few areas with cloud cover, will be accomplished in the next year.

Data Base Gathering:

The efforts of the TTF's in the fall of 1975 resulted in the identification of existing baseline data for the State of North Dakota and established priorities for the collection of still needed data. On the basis of these priorities, a number of contracts were awarded (table 1). Although most of the data gathering was restricted to the southwestern corner of the State, several contracts were for the entire State (e.g., the mapping and evaluation of known paleontologic, archaeologic, and historic sites in North Dakota). An early requirement of each contract was the submission of existing bibliography relevant to that contract for entry into the R^3S system.

The biology projects were the most numerous. Each contractor was required to identify representative sites in the southwestern part of the State, census the diversity and population of species, whether they be animal or plant, and integrate the results with all existing work previously accomplished for those species in North Dakota. An important part of each written report, required at the end of each contract, was the recommendations for further evaluations and for the establishment of permanent monitoring sites.

REAP System:

The heart of all the REAP activities is the establishment of the REAP system, an automated geographic-based data system. Collection of data is of no value unless the data are used. The goal of REAP was to build a computer system which could store data, perform integrated analyses, and make data more readily accessible to the decisionmakers of North Dakota. On the basis of the recommendations presented by the IBM report (IBM, 1976b), the REAP staff developed an alternative to upgrading the state computer to an IBM 370/158. A scientific timesharing computer was recommended, and eventually a Harris system 140 was purchased. Peripherals include 640 million characters of disk storage. But, the REAP system is more than just a computer; it also includes digitizers, plotters, graphics displays, highly specialized software, and analysts. Although some of the software to enter, store, and analyze the data was purchased outright, much of the software was developed by the REAP system staff. It is expected that by the fall of 1978 the REAP system will have a wide variety of data available for use. Outputs will consist of reports, maps, statistics, composite mapping, and graphs and charts. Many data bases located outside the State of North Dakota will not be directly inluded in the REAP system; rather, they will be accessed by computer hookup. Table 2 lists the types of data that are expected to be available to the decisionmakers of North Dakota by late fall of 1978. This, however, is just a beginning.

WATER DATA

With respect to coal development, the two prime areas of concern for North Dakota decisionmakers are air quality and water quantity and quality (reclamation, the primary concern a few years ago, seems to be under control). The need for reliable water data to address those concerns is obvious. Further, since REAP is intended to provide a holistic approach to an entire range of environmental analyses, water data is a critical part of the REAP data base. REAP has approached the access and use of water data in several ways, each of which is described in the following sections of this paper.

TABLE 2. REAP DATA BASE PRIORITIES
1977-79 BIENNIUM

1. STATEWIDE DATA

Distribution of prime farmland
Distribution of native range
Distribution of irrigable soils
Geological type formations and members
Coal Mines
Oil and gas wells
Mineral resources
Topographic data
Historical sites
Archaeological sites
Paleontological sites
Land cover - Landsat data
Land ownership - surface
Land ownership - minerals
Federal and state leased lands
Energy transmission facilities
Energy conversion facilities
Transportation facilities
Political and section boundaries
Drainage basin boundaries
Distribution of lakes, streams, and wetlands
Water use permits
WATSTORE
Rare, unique and fragile vegetation
Forest inventory
Rare, unique and endangered species
Grasshopper data
Parks and outdoor recreational sites
School district boundaries
Census data
Selected fiscal data

2. DATA FOR A SELECTED COUNTY(S)

Distribution of saline soils
Flood prone areas
Ground water distribution
Construction capabilities
Near surface permeability
Vegetation maps
Potential vegetation maps

3. DATA FOR SELECTED AREAS

Grassland production data
Game habitat inventory
Population of selected animal, bird, and fish species

Baseline Data Collection and Analysis of Existing Data:

Several REAP projects have addressed the importance of water in southwestern North Dakota. The aquatic mollusk and the fish census studies (see table 1) included the collection of water-quality data for the purpose of defining the relationship of water quality to species population and health. The most important study, however, was to assess the water resources of the Knife River Basin, the basin most affected by coal development. Two agencies were funded for that study. The North Dakota Geological Survey (NDGS) was contracted to map the surface and subsurface geology and define the hydrogeology of the basin. The North Dakota State Water Commission (SWC) was contracted to collate, evaluate, correct, and standardize available water data. These two projects, due to be completed by May 30, 1978, have encountered problems associated with the use of existing water data. First is the serious problem of using water data from numerous sources and a variety of dates. The SWC is required, as part of its contract, to standardize all such data. Obvious errors in data collection (wrong elevation for the wells, incorrect formation designation, wrong location coordinates, etc.) could be resolved but were time consuming. Subsurface stratigraphy was probably the most difficult to standardize. The data collection varied from auger to core samples and may have included any or all of various drill-hole instrumentation (gamma log, electrical resistivity, well diameter, etc.). In addition, the assignment of an aquifer to a formation or member depended on the experience of the researcher and on the accepted boundaries of the unit at that time. In North Dakota, as in most other States, the definition of exact unit boundaries is fluid; the names and their limits change almost yearly. It, therefore, becomes a problem to know in what unit an aquifer actually is included, despite what it was called at the time of data collection.

To resolve this problem, the Water Commission convened a meeting with the North Dakota Geological Survey and the U.S. Geological Survey to determine if they could agree on formation boundaries among themselves. It appears that the definition of the units, as proposed by the North Dakota Geological Survey, will ultimately be adopted by the Committee on Stratigraphic Names, of the U.S. Geological Survey.

When the report on the water resources of the Knife River Basin is submitted, it will have resulted in a thorough evaluation of the existing water data for that basin and a standardization of those data. Corrections will be submitted to WATSTORE.

A problem with WATSTORE, however, has delayed completion of the report on the hydrogeology of the Knife River Basin. Not only has it been very difficult to enter data into that system, but it has also been impossible to obtain outputs. We understand that the difficulty has been the result of a change in the WATSTORE staff and a heavy backlog of data. It is critical to REAP that this problem be corrected as soon as possible.

State Water Budget:

REAP's need for generalized water data will probably best be met by determining a water budget for North Dakota, both surface and subsurface. At present, the new industrial demands on surface water stem largely from the plans to expand power generation capacities and coal gasification plants. Of similar importance, however, is the anticipated completion of all or part of the Garrison Diversion Project and initiation of the West River Diversion Project. The new demands on ground water are related largely to recent drought in North Dakota and a surge in irrigation permits, necessitating the drilling of an increasing number of wells. Also, if the Federal Government is successful in acquiring the water rights for much of the West, a known water budget will become increasingly important as the State is required to allocate water resources from a more restricted base.

Hydrological Modeling:

The North Dakota State Water Commission was contracted, in addition to activities described earlier, to conceptualize a water model for the Knife River Basin. While the water budget described earlier does not necessarily require a water model, such a model will enable State decisionmakers to identify the potential alterations in water should certain developments occur, it will serve to identify data that needs to be collected, and it will tend to standardize the analysis used to establish water permits. The Knife River Basin is the site of most of the present coal development.

A major design issue appears to be the determination of whether one model or two models (surface and subsurface) needs to be developed. Several surface, or subsurface, models exist but the state of the art concerning hybrid models seems to be very primitive.

Access to Water Data Repositories:

One of the unique aspects of the REAP system is the availability of very detailed descriptions of all data contained within the data base through online terminals. Water data residing at Federal sites (i.e., WATSTORE) will be described in a similar manner except that their descriptions will include a statement indicating that the data does not physically reside at the REAP site.

Upon request, REAP personnel, using the REAP system's Remote Job Entry capabilities, will access data at a remote site and load it into the REAP data base, making it available for analysis in conjunction with the myriad other data contained at REAP. When analysis has been completed, the water data will be purged from REAP's files.

It should be clear that REAP's goal is to access and make water data available, <u>not</u> to duplicate existing Federal water data bases.

CONCLUSIONS

Several significant conclusions can be drawn as a result of the accomplishments of REAP so far. First, although it is clear that the development of such a system is a large and complex task, the effort to date indicates it is feasible. In addition, the development of REAP demonstrates that it is possible to bring together research specialists and decisionmakers with a wide range of interests and arrive at a design for a comprehensive, integrated, and practical system. Of critical importance to this system is the accessibility of water data. Not only is such data necessary to determine water quality/quantity (amounts and trends), but also to permit evaluation of the interrelationships of water to such parameters as soil, vegetation, animal life, and health. NAWDEX is intended to serve REAP in making water data more readily accessible for these users.

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RECOMMENDED METHODS FOR WATER-DATA ACQUISITION--
A GUIDE TO DEVELOPING NAWDEX DATA-HANDLING STANDARDS

By A. I. Johnson[1/]

Other papers presented at this NAWDEX membership meeting not only demonstrate the increase in quantity of water-resources information but also indicate how the demand for such information has increased--mainly over the past decade. Furthermore, the increased demand for information on which to base sound decisions for developing, regulating, and conserving the Nation's water resources has emphasized the need for collecting, analyzing, and storing water data of known quality. Frequently, there are few, if any, indicators as to the quality of the available data in storage--a problem that can be attributed primarily to the many different data-collection methods and data-handling procedures used by various organizations. The magnitude of this problem is better understood when it is realized that about 30 Federal agencies, hundreds of State and local agencies, and an untold number of private organizations in the United States collect and store water data.

The need for maximum comparability, reliability, and usability of water data was a primary concern to the Office of Water Data Coordination (OWDC) when it began implementing Office of Management and Budget (OMB) Circular A-67. To accomplish its task, OWDC established interagency working groups on data-collection and data-handling methods to develop improved efficiency and methodology for generating, storing, disseminating, and using water information. The activities of the data-collection working group, the "Federal Interagency Working Group on Designation of Standards for Water Data Acquisition," resulted in a preliminary report entitled "Recommended Methods for Water-Data Acquisition," which was distributed in 1973. I believe that the strong interest in this activity and the need for a publication of this type were amply demonstrated by the fact that over 10,000 copies of the preliminary report were distributed to requesters in the United States and abroad.[2/]

In 1964, OMB issued Circular A-67, which prescribed guidelines for coordinating Federal water-data acquisition activities. OWDC was delegated to lead the coordination program by the Department of the Interior through the Geological Survey. To advise and counsel OWDC, the Department established the Interagency Advisory Committee on Water Data (Federal) and the Advisory Committee on Water Data for Public Use (non-Federal). From the beginning of

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2/The increasing interest in a U.S. policy for standardization is demonstrated by the "National Standards Policy for the United States" (Federal Register, Feb. 14, 1978). That policy statement was prepared by a National Standards Policy Advisory Committee consisting of representatives of both Federal and non-Federal organizations.

the recommended-methods activity, the Federal and non-Federal advisory committees provided considerable support and advice which contributed to successfully developing the report on recommended methods for water-data collection.

At their meetings in 1973, the Federal and non-Federal committees recommended that a Federal ad hoc subcommittee be organized to decide how the recommended-methods activity should progress from release of the preliminary report. The subcommittee, formed from 10 members of the Federal advisory committee, recommended that a new handbook should be written, which would expand the preliminary report to include the entire hydrologic cycle. The subcommittee also recommended establishing the Coordinating Council for Water-Data Acquisition Methods headed by a Methods Coordinator in OWDC.

I was designated Methods Coordinator and representatives of 18 Federal agencies were organized into the Coordinating Council to advise me on policy and guidelines from the Federal viewpoint. In addition to the 18 Federal representatives, there is a liaison member from Canada and there will soon be one from Mexico. The heads of all concerned Federal agencies were invited to nominate personnel to any of 10 technical working groups which would produce the new "National Handbook of Recommended Methods for Water-Data Acquisition." Over 170 technical personnel representing 25 Federal agencies were nominated to the 10 working groups, with each working group responsible for writing a chapter of the "National Handbook."

The non-Federal community was also encouraged to assist in preparing the new handbook. The Working Group on Recommended Methods was formed from 10 members of the non-Federal Advisory Committee with representation from such organizations as the American Society of Civil Engineers, Association of American State Geologists, Water Pollution Control Federation, Association of Western State Engineers, and several State and interstate agencies. In addition, the American Society for Testing and Materials, American National Standards Institute, American Water Works Association, American Public Health Association, and other technical and standards-setting societies were consulted, and close communication is maintained with them on this activity. Existing standards will receive maximum reference in the handbook, and these organizations will integrate the recommended methods into their standards structures, thus providing for wider review and use by Federal and non-Federal organizations alike. Figure 1 illustrates the organizational relationships for Federal and non-Federal participation in the "National Handbook."

The first meeting of the 10 working groups took place in January 1975. I believe that a remark made by the chairman of the Federal Advisory Committee, Mr. J. S. Cragwall, Jr., not only provided good philosophical direction to subsequent efforts for recommending methods for data collection but also provided direction for further efforts towards recommended standards

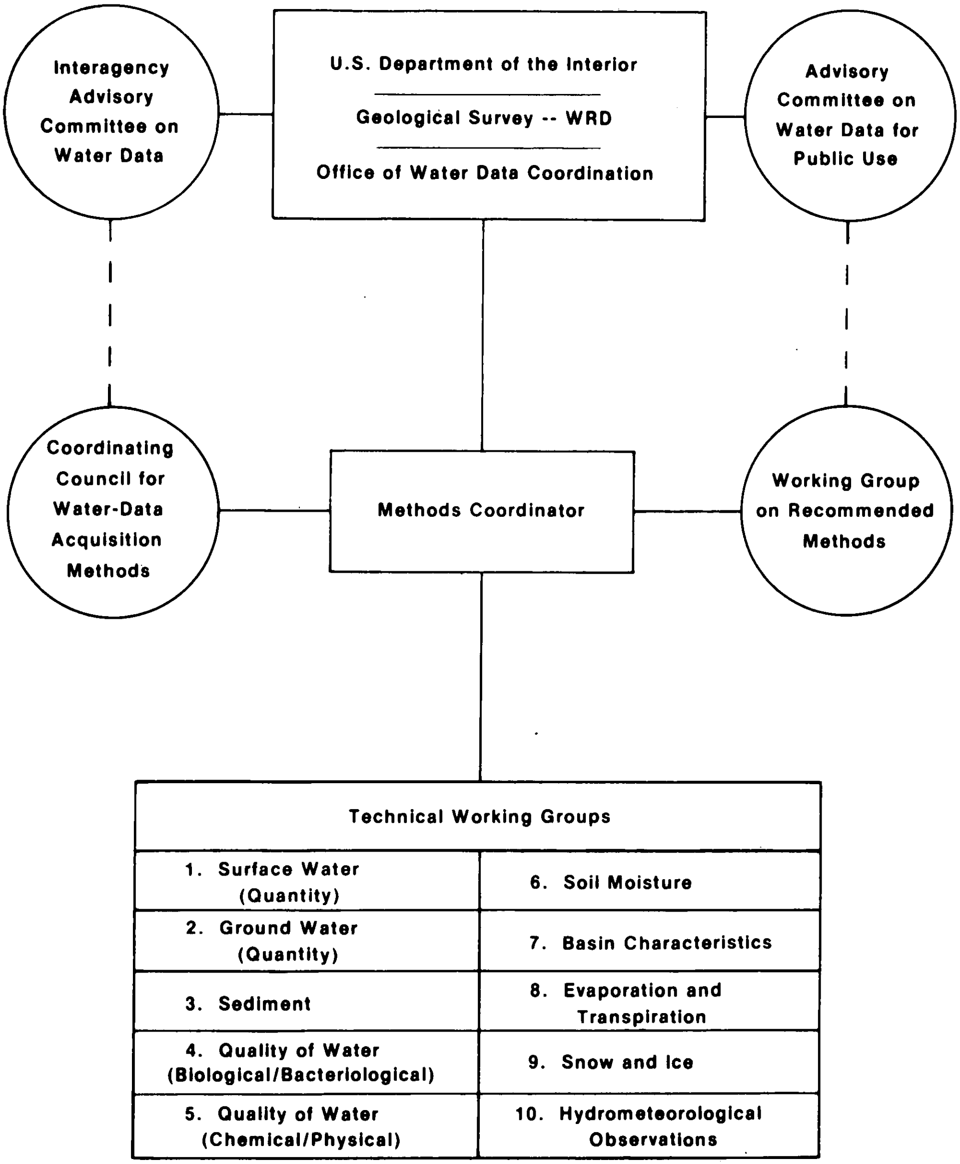


Figure 1.--Organizational relationships for Federal and non-Federal participation in the "National Handbook."

for the handling and exchange of water data. I quote: "These three attributes--comparability, reliability, and usability--will justify the effort, for along with them will go improved efficiencies in generating, storing, disseminating, and using water information." I would now like to describe the "National Handbook" and associated activities in hopes that they can serve as a guide for developing NAWDEX recommended standards.

As can be concluded from the organizational chart, the "National Handbook" presents the water-data acquisition methods recommended by a representative group of the major U.S. water-data collectors and users. The handbook, which will be continuously updated, includes field, laboratory, and office methods for acquiring data related to the quantity and quality of water in streams, lakes, reservoirs, estuaries, underground, and in the atmosphere. A specially designed, loose-leaf notebook allows the Handbook to be easily corrected and updated to include the latest technology. In the chapters, detailed methods descriptions are given only where references, manuals, or standards of acceptable quality are not readily available. However, references are given in each chapter to help locate more detailed information on theory or step-by-step procedures. Sufficient information is provided in each chapter for the user to evaluate and select the best methods for obtaining desired data. Nomenclatures and definitions, units of measurement, discussion of necessary equipment, precision and accuracy evaluation, and recommended quality-control procedures are also included in the chapters where necessary. The handbook will consist of 10 technical chapters, an introduction, and an appendix of recommendations on metric units and other information related to metrication of hydrologic measurements.

Chapter 5 on water quality was distributed in January 1977, and an update was distributed in January 1978. Four chapters have been through the complete review process and are ready for final typing for printing. The other five chapters are in various stages of completion; we hope to have all chapters completed by early next year.

Other subjects are being considered for inclusion in the handbook such as, a chapter on the collection of water-use data. The chapters presently scheduled for publication concentrate on collecting or generating water data. Members of the two advisory committees, as well as other reviewers and users of the early section of the handbook have urged that the "National Handbook" should also contain recommended methods or standards for storing and retrieving water data to improve the compatability and usability of the stored data no matter who collected the data or where they are stored.

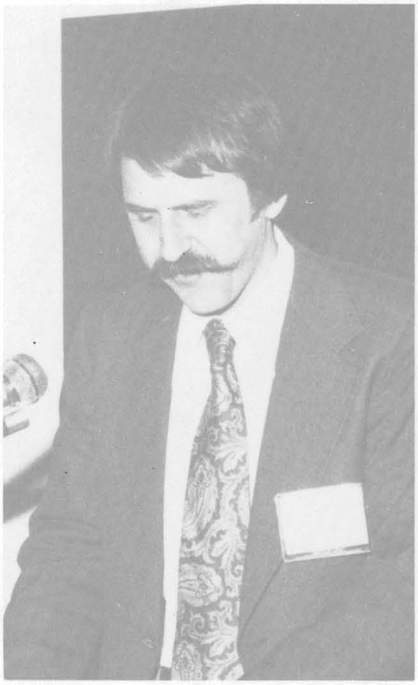
During this conference one working group will meet to determine if the time is ripe for initiating standards, and if so, whether the existing procedures and organizational structure that have proved successful in developing chapters on water-data collection could be used to advantage in developing the NAWDEX standards.



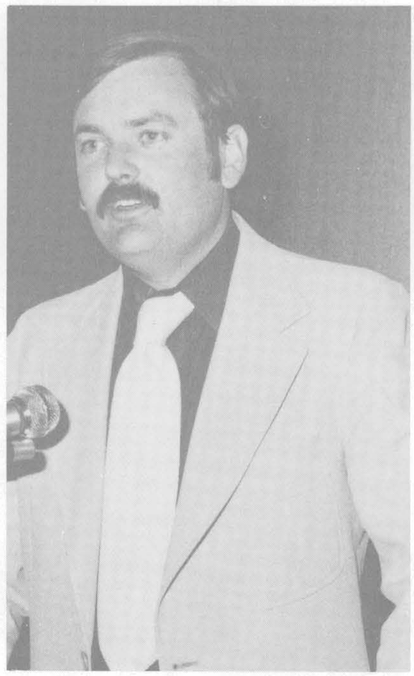


PROGRAM SPEAKERS

Top row, left to right:
Walter I. Knudsen, Jr.
Robert R. Freeman
Bernard A. Shafer
Bottom row, left to right:
Arnold I. Johnson
Harold S. Lippmann







PROGRAM SPEAKERS

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Mahendra K. Bansal
Miguel A. Medina, Jr.
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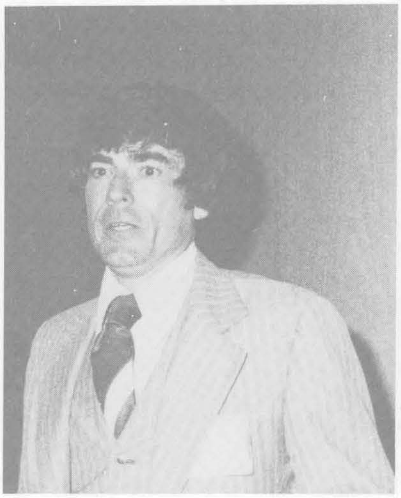
John R. Reid
Richard V. Giddings








PROGRAM SPEAKERS

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Frederick H. Ruggles, Jr.
Russell H. Langford
Joseph S. Cragwall, Jr.
Middle row, left to right:
Melvin D. Edwards
John H. Wilson
Solomon M. Lang
Bottom row, left to right:
Raymond A. Jensen
Charles R. Showen

NAWDEX PROGRAM OBJECTIVES FOR FISCAL YEAR 1979

By Melvin D. Edwards[1/]

I will not go into an in-depth discussion this morning of our program objectives and priorities for Fiscal Year 1979. Rather, I would like to outline some of the major program elements that need close attention or additional support next year. I am sure that many of our objectives will be better defined during our panel sessions today. Also, I expect new topics to be presented which we haven't yet considered. The recommendations of today's sessions will be given careful attention and your suggestions will be fitted, where possible, into our program objectives.

We will, of course, continue our efforts to increase our membership. This is important if we are to continue to improve our interagency communication and to expand our information resources and services. I would also hope to strengthen the interaction between the Program Office and the membership representatives. There are several needs in this area which I would like to emphasize. There needs to be an effort to improve our NAWDEX communication channels within our member organizations. Many offices in large member organizations are often not aware of the NAWDEX program and its capabilities. There is also a need for the membership to provide more affirmative input in helping us to expand our membership and improving the public awareness of NAWDEX. Aids such as the new brochure defining the program and its services available are provided for this purpose.

We must place a higher priority next fiscal year on improved development and expansion of the Water Data Sources Directory (WDSD). A field review of the present contents, a more viable program for data-gathering and input, and the first publication of its contents are necessary to improve its utility and to more accurately and completely define the data holdings and services of the registered organizations. Implementation of the expanded capabilities to include sources of water-related data will begin early in Fiscal Year 1979. The newly designed retrieval software included in these capabilities will greatly expand the utility of the Directory in our data-response activities.

In our data-indexing activities, we will continue our efforts to assure the input of information by all participants into the Master Water Data Index (MWDI). Consistent NAWDEX-designed encoding procedures will be implemented as soon as possible, continent upon approval of these procedures for interagency use by the Office of Management and Budget. Indexing of the STORET and WATSTORE systems will also be continued. A review of the MWDI is planned early in FY 1979 to appraise its current utility and to define any needed changes in the structure and contents of the data base. The membership will be asked to participate in this review. Specifications of needed modifications

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will be developed and modifications implemented later in the fiscal year. Specifications are also planned to be developed for adding the facility for indexing areal-related and nonpoint source data. This may include either the development of a new data base or an extension of the MWDI. Maintaining a high degree of flexibility in our data-indexing procedures is critical to meet the future program needs.

Hopefully, there will be an increased interest among the membership in developing computerized interfaces between their data systems and the MWDI. The Program Office is prepared to discuss such developments and assist in these efforts to the highest degree possible within our available resources.

There is a growing need for a viable system that generates meaningful management and summary statistics from the MWDI. Software to perform these functions is planned for FY 1979. Upon its completion, a digest of the contents of the MWDI will be published on a periodic schedule.

We must maintain a continuing effort to improve and expand our service capabilities. An expansion of personnel resources in the Program Office to support this activity is planned next year. We will also continue to encourage related services of member organizations to become a part of our Local Assistance Center network. All operational service and data systems within the membership should consider this much needed function. Working relationships with other member systems for the exchange of services will also continue to be expanded wherever possible to assure maximum utilization of viable, existing services.

Another need is that of a more complete description of systems, products, and services available through the membership. The WDSD is a viable mechanism for this purpose. A compendium of systems descriptions for member organizations is also being studied as a supplement to the WDSD. If this proves to be a desirable approach, such a compendium will be developed during next fiscal year and published.

The task of developing recommended standards for the handling and exchange of water data is being initiated here today. The necessary actions to develop this task into a full-scale program will be taken during the remainder of this fiscal year and early next fiscal year. Our course of action on standardization is expected to be defined during today's sessions.

These objectives are by no means firm or complete. I offer them to you this morning primarily to stimulate your thinking. A more complete report will be forwarded to you after the conference for your review and comment.

CHARGE TO AD HOC PANELS OF THE FIRST NAWDEX MEMBERSHIP CONFERENCE

By Melvin D. Edwards[1/]

I consider the ad hoc panels, to be conducted the remainder of today, as a most important part of our conference and a source of valuable input to our program for the forthcoming year. We have briefly discussed our program objectives for next year. It is now time for us to approach the task of assessing the program as it has been developed to date, to define its deficiencies, and to develop and recommend procedures for its improvement. The membership structure of NAWDEX is somewhat unique in its operational concept. I strongly believe that this structure is our key to developing a strong, viable, and comprehensive program. Today is our first opportunity to take personal advantage of that structure.

Looking briefly at our individual tasks:

1. The Ad Hoc Panel for Program Administration, Management, and Coordination is charged with the task of appraising the development and effectiveness of the program. The panel has been asked to address the subjects of improving the public awareness of NAWDEX; expanding the membership; improved coordination processes through program office outputs, better interaction within the membership, and improved communication internally within member organizations; improvement of management and administration through more affirmative input by members; better identification and focus of local and regional needs, and more extensive implementation of NAWDEX concepts at the local and regional level; program deficiencies and needs; program objectives; and our next membership conference.

2. The Ad Hoc Panel for Water Data Indexing and Technical Systems Development is charged with the task of appraising the indexing and systems development thus far. It has been asked to review developing and planned systems and to identify new, needed systems; to review and comment on our established procedures for indexing; and to help establish priorities for future advancements in these important areas.

3. The Ad Hoc Panel for Request, Response, and Service Activities is charged with the task of appraising our data request/response activities and helping us to improve and expand this important service. They have been asked to focus on improving the operation of and expanding our Local Assistance Center network; to review the policy and procedures established for this activity; and to help us improve our mechanisms for identifying user needs, integrating new and relevant services into the system, and identifying additional, needed services. I would like to ask each of you that are associated with existing or developing data systems or services to give

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strong consideration to adding your support to our Local Assistance Center network. An easily accessible and responsive network is imperative for the full success of this important segment of our program.

4. The Ad Hoc Panel for Recommended Standards for the Handling and Exchange of Water Data has, perhaps, the most challenging task of the day. Their session marks the implementation of this important project. I envision that it will require a lot of work and a minimum of 5 years to develop a viable set of draft recommendations. The panel has been charged with the specific task today of developing a plan for implementing the activity with emphasis on operational procedures, time scheduling, priorities of development, and identification of existing standards that can be readily endorsed. I have asked that the development plan include provision for input by all NAWDEX members. There is an increasing demand for indicators of the quality assurance of data and better compatibility between data resources. I believe that the timing of this project is consistent with our responsibility to respond to these demands.

Tomorrow, we will hear reports of the results of our efforts today and have an opportunity to discuss them. Please do not hesitate to call upon the NAWDEX staff if you need any support during your sessions today.

REPORT OF THE AD HOC PANEL ON REQUEST, RESPONSE, AND SERVICE ACTIVITIES

I feel that the Ad Hoc Panel for Request, Response, and Service Activities, which I had the pleasure of chairing, has compiled a good list of recommendations. The afternoon was not without its frustrations, however. For instance, we would spend 20 or 30 minutes discussing a particular topic and formulating what we thought to be a very profound and original recommendation to NAWDEX, only to have the NAWDEX support staff tell us that the Program Office was already on that course of action. At this point we would amend the recommendation by including the prefix, "The NAWDEX Program Office should continue to . . .". With that introduction, I will proceed to the formal recommendations of the Ad Hoc Panel for Request, Response, and Service Activities.

The NAWDEX Program Office should continue to seek access to water data systems which are nationwide in scope and are available through other public and nonpublic organizations. As much as possible, the Program Office should facilitate access to such systems for NAWDEX Local Assistance Centers and should, in fact, encourage direct access by the Centers.

Many states are recognizing the need to coordinate natural resources and related data at the State level. As a result, many centralized data banks and information systems within State governments are either being designed or are already in development. NAWDEX should make a concerted effort to solicit participation from State natural resources information systems as Local Assistance Centers. One advantage of this course of action would be an increase in the amount of data indexed in the Master Water Data Index.

The panel believes that some expansion of the Local Assistance Center network is needed, but that such expansion should be a deliberate process. This is particularly important in light of the previously mentioned efforts in many States to centralize such services. The number of Local Assistance Centers should be limited to a maximum of two in most States, one of those being a State-level organization. The NAWDEX policy of designating U.S. Geological Survey field offices as Local Assistance Centers should be continued, at least until adequate capabilities are developed at the State level for quick response for water data needs. In States such as Texas, which have developed extensive capabilities to respond to water data needs, a single State-level Local Assistance Center is recommended.

It is also recognized that regional offices of various Federal agencies provide data and other services to an extensive user community. NAWDEX should seek to establish Local Assistance Centers within selected entities from this group. Close coordination between Local Assistance Centers who serve users in common geographic areas should be strongly encouraged by the Program Office.

The Request, Response, and Service Activities Ad Hoc Panel agreed that the NAWDEX Policies and Procedures Manual is very well organized, adequately covers the subject, and can be used easily by members. Anticipating the need for policy changes as NAWDEX continues to develop, the panel recommends that the manual be published in looseleaf form for ease of update.

It is also the consensus of the panel that Local Assistance Centers should be encouraged to submit a statement to the Program Office of appropriate policies and procedures, information on fees for services, and a resume of capabilities which exist for manipulation and presentation of data indexed in NAWDEX. Such information should be published in an expanded "Directory of Local Assistance Centers of the National Water Data Exchange." Consideration should also be given to including selected items relating to charges of Local Assistance Centers for services and other policies and procedures in the Water Data Sources Directory.

The Program Office should expand the existing capability for identifying general capabilities associated with each data file included in the Master Water Data Index (MWDI). Output capabilities such as computer-generated graphic products and microfiche should be identified in the MWDI.

Since Local Assistance Centers are in constant contact with data users, it seems appropriate that a mechanism be established within the Program Office to compile a list of members' needs for additional capabilities from the data systems which have established cooperative programs with NAWDEX. Future NAWDEX membership conferences might likely provide a good mechanism for formalizing needs in this area and transmitting them to the appropriate entities. It also seems appropriate to include representatives of such data systems on the agendas at membership conferences in order that members be apprised of newly included data and capabilities, as well as scheduled system enhancements.

The NAWDEX Program Office should be provided a list of contact persons for inquiry referral in Local Assistance Centers. Local Assistance Centers should be encouraged to notify the Program Office of changes to their list in order that referrals might be handled efficiently.

The Request, Response, and Service Activities Panel also addressed the important area of documenting and tracking user requests. It was agreed that continual quarterly reporting is necessary and that the form currently used for such reporting by the Program Office is adequate. It is suggested that NAWDEX consider developing computer software to track individual accesses to the Water Data Sources Directory and Master Water Data Index. Each access could be tied to individual Local Assistance Centers through computer account numbers. Potential reporting errors would be eliminated by this procedure and usage of these data bases by non-NAWDEX organizations would be documented.

New capabilities which the panel recommends include:

1. An automated bibliographic cross-reference file to associate entries in the Master Water Data Index to

available published supportive information.

2. Computer-Output Microform capabilities should be considered by NAWDEX as the Master Water Data Index continues to grow.

3. Additional software to provide expanded selection capabilities for the MWDI should be developed. Expanded capabilities should include selection of data indexes by length of record. It is often necessary for a user to use data for a minimum continuous period of record. By allowing the user to indicate the minimum acceptable period of record as selection criteria, the MWDI capabilities would be significantly enhanced. In addition, the availability of a histogram generation program to portray the relative frequency of stations with selected lengths of record would be useful.

Once again I want to say that Doug Edwards, Program Manager, and the Program Office staff have done a commendable job in implementing a well-conceived system. The suggestions and recommendations presented by the Ad Hoc Panel for Request, Response and Service Activities, as you have probably noted, mainly relate to expansion of the system. As hard as we tried, we couldn't find anything that we could ask them do over in better fashion. We appreciate the opportunity to provide this input, and we trust that it will be of some benefit in the continued development of this great system.

Respectively Submitted By:

John H. Wilson, Chairman

Participants:

John H. Wilson, Texas Natural Resources Information System
William E. Skimin, Great Lakes Basin Commission
T. W. Johnson, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University
J. B. Burford, Science and Education Administration--Agricultural Research, U.S. Department of Agriculture
Robert R. Freeman, Environmental Data and Information Service, National Oceanic and Atmospheric Administration
John R. Reid, North Dakota Regional Environmental Assessment Program
Ljubo Lulich, Water Resources Scientific Information Center, Office of Water Research and Technology
Mahendra K. Bansal, Nebraska Natural Resources Commission
Douglas Glysson, U.S. Geological Survey, Water Resources Division
Pauline Juarez, U.S. Geological Survey, Water Resources Division
Herbert Kroehl, Environmental Data and Information Service, National Oceanic and Atmospheric Administration
John C. Brekke, Desert Research Institute, University of Nevada

NAWDEX Staff Support Personnel: Marian R. Guckert and Beverly M. Myers

Panel 4. Request, Response, and Service Activities

REPORT OF THE AD HOC PANEL FOR RECOMMENDED STANDARDS FOR THE HANDLING AND EXCHANGE OF WATER DATA

The directed purpose of this panel was to develop a plan for implementing a recommended standards activity within the framework of NAWDEX (the National Water Data Exchange). As a beginning step we were asked to draft a series of procedures for (1) developing the standards, (2) designating a tentative time frame for accomplishing the task, (3) establishing an initial priority list of items for which standards must be developed, and (4) identifying existing and well-known standards or systems which may be considered as a basis for standards development. The panel was also asked to comment on metrication with respect to the above directives. This report is a synthesis of the panel deliberations and additional comments from the general discussion with all conferees.

It was immediately recognized by the panel members that we would not be able to complete our assigned task as noted above. There were two reasons for this conclusion. The first reason was just simply the amount of work that would be required within the time frame allotted. The second reason was the diverse makeup of the panel, with each member expressing his or her particular needs and orientation which would, if the time were available, contribute in a very positive and concrete manner to the directives as a whole.

Consequently, the panel developed the following recommendations for presentation before the conferees.

I. The panel recommends that NAWDEX and OWDC (Office of Water Data Coordination) jointly organize a working group from NAWDEX members and other organizations vitally interested in water-resource data to implement the purpose stated below.

<u>Purpose:</u> To develop recommended optimal methods for the handling and exchange of water-related data as specified by:

(1) Data Handling - A common method relating to the identification of the organization holding data and site location of the data, and

(2) Data Exchange - Data provided to a user by the agency collecting and holding the data.

II. It is further recommended that this working group be established by September 1, 1978, and that a report relating to their progress be given at the 1979 NAWDEX Membership Meeting. The report should include a schedule for meeting the <u>Purpose</u> objectives.

III. It is further recommended that the items to be addressed by the working group should include, but not be limited to, the following:

Federal Information Processing Standards (FIPS) codes
Hydrologic Units
Identifying type of data storage
Site Location (latitude, longitude, local identifiers, etc.)
Prioritizing data code reviews (common regional vs. unique organizational)
A multiplicity of common computer data exchange formats
Identify accepted standards via codes.

IV. It is further recommended that the term <u>methods</u> be used in lieu of the term <u>standards</u>.

In presenting these recommendations, we note that the establishment of a working group, as in Recommendation I, may not be the simple task envisioned by the panel due to Department of the Interior rules and regulations governing such activities. It is the conclusion of the Ad Hoc Panel Chairman that the establishment of a working group to implement the stated purpose is a good idea and will be done, but it's membership and time schedule may be affected by Department of the Interior rules and regulations.

The panel did not discuss metrication. It was felt that this was a political and economic problem, and as far as data handling and exchange were concerned, there would not be any technical problems in converting data.

Respectfully submitted,

Walter I. Knudsen, Jr., Chairman

Participants:

Walter I. Knudsen, Jr., Colorado Division of Water Resources
Stuart C. Ross, U.S. Environmental Protection Agency, Region V
Leo Boychuk, Water Resources Document Reference Centre, Inland Waters Directorate, Dept. of Fisheries and the Environment, Canada
Dr. Miguel A. Medina, Jr., Dept. of Civil Engineering, School of Engineering, Duke University
Charles R. Showen, Automatic Data Section, Water Resources Division, U.S. Geological Survey
Arnold I. Johnson, Office of Water Data Coordination, U.S. Geological Survey
Norman Miller, U.S. Soil Conservation Service
George Cawlefield, Montana Department of Natural Resources
Kathy Svanda, Minnesota Pollution Control Agency
Bernard Shafer. U.S. Soil Conservation Service
David Ripley, North Dakota State Water Commission
Gerard S. Witucki, National Park Service
Ronald E. Hermance, National Park Service

NAWDEX Staff Support Personnel: Gerald L. Thompson

Panel 2. Recommended Standards for the Handling and Exchange of Water Data

REPORT OF THE AD HOC PANEL ON WATER DATA INDEXING AND TECHNICAL SYSTEMS DEVELOPMENT

In opening the panel session the chairman suggested to the group that this membership meeting is an opportunity to express "grass roots" demands for products and services of NAWDEX, and it is also an opportunity to be reminded of the requirements and constraints that must exist for a national-scale system that serves such a wide variety of uses. The panel session should, therefore, be regarded as a dialogue through which the Program Office staff and NAWDEX members can become better acquainted with each other's capabilities and needs.

Topics to be addressed by the panel were divided into seven categories, and a "discussion leader" was appointed for each (see panel participant list at the end of this report). For each topic the discussion leader presented his views, other members contributed their comments and suggestions, and the NAWDEX staff representatives responded. Discussion leaders compiled the comments on their assigned topics and these were later consolidated into six "major findings."

The major findings represent the chairman's attempt to characterize the panel's concerns. However, no effort was made to achieve complete consensus during the session. The full outline of individual comments and suggestions follows the "major findings."

Major Findings of Ad Hoc Panel

1. System documentation should be synthesized and careful attention given to an expanded training programs and assistance to new members, as well as to new Local Assistance Centers.

2. New data bases to be indexed should be selected on the basis of priorities established through polling of potential users. The system should be modified to allow locational referencing for linear- (river reach) and areal-based data.

3. Inducements, such as information on potential benefits to members, should be provided to encourage voluntary participation in indexing.

4. It is not necessary or practical for NAWDEX to provide access to data bases it indexes and/or is affiliated with.

5. Priorities for allocation of increased funding should tend heavily towards users' needs, especially for technology transfer, field assistance, and index expansion to include data bases that users agree are needed to increase NAWDEX patronage.

6. NAWDEX should solicit evaluations and updates of information in the Water Data Sources Directory by listed agencies, and then publish and distribute the Directory.

Specific Comments and Suggestions by Members of the Ad Hoc Panel

1. Systems Documentation and Training (Charles Nethaway): Existing documents are good but need to be enhanced, organized into a single unit, and have an overview that takes the user through the system. Training and funding is needed to let member personnel become aware of how to use NAWDEX, and of what advantages there are in using the NAWDEX system. Some suggestions for attaining these goals are as follows:

Organize all NAWDEX documentation in a multivolume, cohesive unit.

An overview document is needed (with a flowchart), on how to use the total NAWDEX system. (Such a document was distributed at the meeting.)

Distribute brochures and samples of output from affiliated systems.

Circulate an order form which lists available documents.

Write a manual on how to use timeshare and batch terminals; include information on control cards, phone numbers, and how to actually use the data bases (with applications examples).

Insure that designated representatives within member organizations receive all documents.

Update and publish an active membership mailing list.

Provide information on how to access systems of other members, and how to handle referrals (with examples).

"Flag" documents as technical or non-technical.

Enhance the documentation on the Master Water Data Index (MWDI) data preparation input with respect to Part 5 of the encoding forms. More space needs to be provided in the fields to be encoded.

Provide training in NAWDEX systems for non-LAC (Local Assistance Center) member organizations similar to that of the LAC NAWDEX seminars, and conduct "hands-on" workshops throughout the year.

Prepare material suitable as an introduction for potential NAWDEX users. (An excellent brochure for this purpose was distributed at this conference.)

NAWDEX staff members should educate the water community about the NAWDEX program by making presentations to professional and academic societies.

The Civil Service might be contracted with for some of the training, particularly on System 2000, and possibly for utilization of NAWDEX data bases.

Provide non-member training on how to index data for the MWDI.

Set up a toll-free telephone line for questions and answers.

Prepare a manual or handbook on training.

Hold a NAWDEX user symposium.

Acquire funds for training program development.

2. Current and Planned NAWDEX Systems and Data (Keith Bayha): Information about current systems and data in NAWDEX is presented in available brochures and other written materials and includes surface water, ground water, and water quality.

* Member systems accessible through NAWDEX need to be inventoried and and published (i.e., water rights files maintained by States, weather data maintained by NOAA).

* OMB circular A-67 sets current "sideboards" on authority for data inclusion in NAWDEX. It is recommended that the Department of Commerce seek funds to finance the integration of precipitation data from off-stream stations in NAWDEX indexing system. Distinction between the EPA agency codes for data in STORET and the operating organization who collected the data should be shown in the Master Water Data Index.

* Index the USGS unit value files of WATSTORE in NAWDEX.

Documentation of ground-water parameter groupings is needed. Show sources of data to define any duplication of data storage and identify the original source of information for water quality data indexed.

Planned systems should include:

Revised software for continued indexing of STORET (maintain current stations data flow, add new stations, and terminate obsolete stations). (CACI expects to complete this by August 1978.)

Integration of digitized files of hydrologic unit codes into MWDI update system. (This task is complete except for sites without longitude and latitude and those sites lying close to hydrologic unit boundaries which require verification research.)

Expansion of the set of command strings using System 2000 Immediate Access (Natural) Language to facilitate retrieval from the MWDI. (NAWDEX staff is prepared to develop new strings upon request by users. User-developed strings with transferability should be made available to the Program Office for dissemination to others.)

* Improving the software for updating the Water Data Sources Directory with information on sites indexed in the MWDI.

Revision of the Water Data Sources Directory to allow the input of information on water-related data (See Needs section below), and more flexible queries.

* Producing a Water Data Sources Directory, a Water-Related Data Sources Directory, or a combined directory in hard copy for member agency review.

Review and revision of MWDI to incorporate new and needed indexing items (see Needs section below). (Scheduled for FY 1979.)

Development of a design criteria for indexing areal data (Scheduled for FY 1979.) This should include plotted station location displays.

Development of documentation for use of graphic output systems available in NAWDEX. (Scheduled for FY 1979.)

* Development of a family of systems for collecting, storing, and retrieving water-use data both on a national level (first priority) and on a State level (second priority). Include, in addition to traditional water use categories, (1) instream flow for aquatic life, recreation and navigation, (2) commercial component of M & I and (3) withdrawal and return-flow data for off-stream users.

* Development of non-point source pollution data systems, including urban runoff data at both stream and non-stream locations.

* Integration of the stream-reach file (developed by EPA) with hydrologic unit codes to provide a system for storing the substantial list of stream site - specific data (dam sites for dam safety review, instream flow monitoring, energy plant impact monitoring, large scale modeling). A river-mile index might be incorporated into such a file to increase locational specificity of the file.

Needed systems and data extensions identified beyond those current and planned include:

Instream flow recommendations based on adequate field investigation along with methods used, agency, date, and status of implementation. This file has been described in concept and tentatively labeled IFIS (Instream Flow Information System) by the Cooperative Instream Flow Service Group but has not been built.

Biological data base for riverine habitats. This has long been discussed in terms of BIO-STORET and RIMS (Riverine Information Management System) but has not been developed.

Dam operational index categories (releases, timing, etc.), particularly sequentially, over total river reaches. Several systems of this nature exist and could be indexed by NAWDEX.

Index categories and sources of projections of water use (energy, and non-energy) and non-point source pollution, with locations by reaches, river mile, and basin area. This would also apply to projections of future water quality.

Expand categories of information on toxics, based on expected actions by EPA in response to the Toxic Substances Control Act.

In addition there is a need to identify users of various data files and establish priorities for system and data file development. This would aid in determining what is to be added to NAWDEX, and when.

(The asterisks on the items listed above indicate substantial concensus or high priority items identified by this panel.)

3. Member Input and Technical Support of System Development - Areas in which NAWDEX Coordination Could be Useful (Richard Giddings):

(a) Development of standardized formats for the transfer of data among processing sites (both alphanumeric and geometric data).

(b) Development of standardized indexing schemes (not necessarily one scheme).

(c) Inclusion of major State water-related data bases in the NAWDEX system.

(d) Establishment of a file of "experts" and/or "contact persons" with respect to water-related data collection, sources, and analysis.

(e) Development of a software inventory for water-related analysis programs.

4. Problems, Comments, and Recommendations Regarding Data Indexing (John Ladd):

NAWDEX should expand and improve the instructions on indexing or encoding data, particularly, with respect to Part 5 of the new NAWDEX MWDI encoding forms, to assist in common usage by members.

Submitters of new data should be responsible for accuracy of original report and followup verification. Reports or entries of unverified data should not be submitted by members.

NAWDEX should provide close guidance to those members (and others) wishing to index their own existing data bases.

Consideration should be given to incorporation of some type of "data credibility" code or field.

Member input of historical data — need & relevance:

Since historical data are already indexed, it should be continued.

Entry of additional historical data should be based on members' confidence that the information is of significant value, and is credible.

The Water Data Sources Directory could be used to "flag" sources or types of "suspect" data.

Interim versus proposed new NAWDEX indexing procedures:

NAWDEX should move into its new coding format as soon as possible.

Additional training at user level is necessary to assure efficient and consistent use of NAWDEX procedures.

General Comments:

Avoid frequent changes in the indexing procedures.

Provide timely turnaround on new station indexing to facilitate file verification, avoid duplicate encoding, and to provide feedback to members.

NAWDEX should make more demands, at least verbally, on members and submitters to enhance file integrity and "currentness".

5. Automated Interfaces Between the Master Water Data Index and Member Data Systems (Fred Ruggles): NAWDEX should request extra funding and personnel to provide for technology transfer to enhance the capability of States to automate their interfacing capability; to consult with local cooperating organizations to develop automated interfaces; to purchase assistance for the local cooperating organizations to develop automated interfaces; and to provide technology guidance as soon as possible to new members.

6. Members' Use of the Water Resources Scientific Information Center (Raymond Jensen): It would not be useful to directly access the WRSIC data base through NAWDEX. WRSIC operators are well trained and are able to produce more effective searches than those operators with little training. It was noted that NAWDEX members' document citations, supplied to WRSIC in the proper format, would be entered into the data base.

7. The Water Data Sources Directory (Jack Wagar): The panel considers the Water Data Sources Directory (WDSD) an important part of the NAWDEX information base. We recommend that the effort be made to obtain more complete information for the WDSD for all agencies in the Master Water Data Index. Each agency should be furnished a printout showing the information presently contained in the WDSD, and be asked to supply information to update its entry. Participants should also be requested to suggest additional collectors that should be included in the file. Upon completion of the update, the WDSD should be printed and widely distributed, perhaps on an annual basis.

Respectfully submitted,

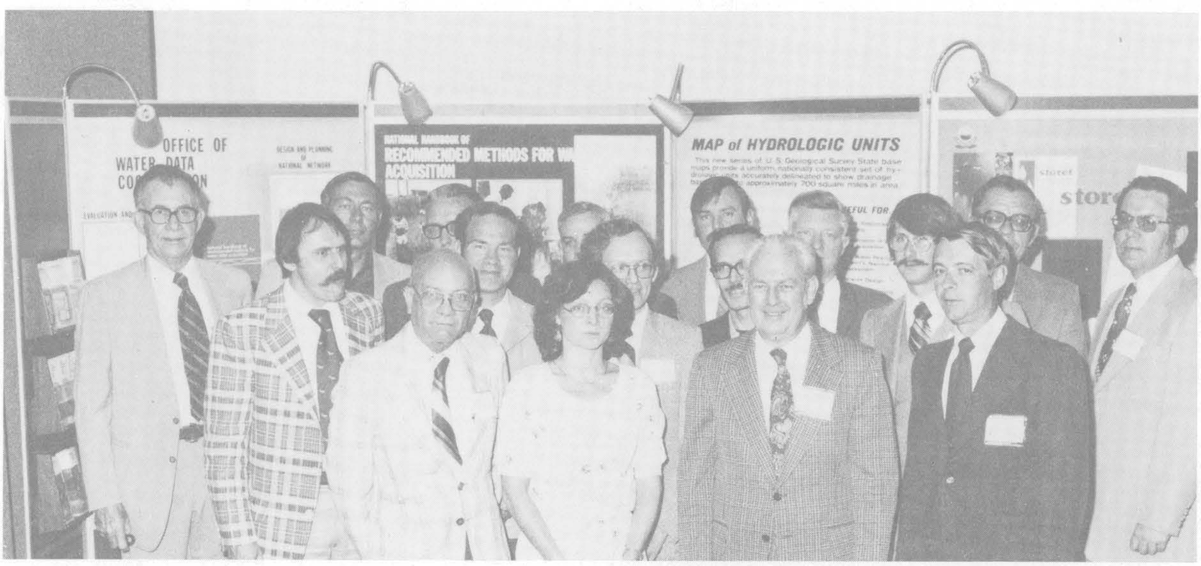
Richard L. Talcott, Chairman

Participants:

Richard L. Talcott, Iowa Water Resources Data System, Iowa Geological Survey
*Raymond Jensen, Water Resources Scientific Information Center, Office of Water Research and Technology
*Charles D. Nethaway, U.S. Geological Survey, Water Resources Division
*John M. Ladd, California State Water Resources Control Board, Dept. of Fish and Game
A. Leon Huber, Utah Water Research Laboratory, Utah State University
John C. Sonnichsen, Jr., Westinghouse Hanford
Robert Bergantino, Montana Bureau of Mines and Geology
*Richard Giddings, North Dakota Regional Environmental Assessment Program
*Fred Ruggles, U.S. Geological Survey, National Water Use Data System
*John E. (Jack) Wagar, U.S. Geological Survey, Office of Water Data Coordination
Verne E. Smith, Wyoming Water Resources Research Institute, University of Wyoming
Sharon Kurtz, University of Arizona, College of Business and Administration
Robert H. Harmeson, Illinois State Water Survey
Randolph R. Newton, U.S. Department of Energy
*Keith Bayha, U.S. Fish and Wildlife Service, Cooperative Instream Flow Service Group
Betty Farrell, Colorado Water Data Bank, Colorado State University

NAWDEX Staff Support Personnel: Gayle Gillingham (USGS) and Pete Webb (CACI, Incorporated)

*Group leaders for individual topics.



Panel 3. Water Indexing and Technical Systems Development

REPORT OF THE AD HOC PANEL FOR PROGRAM ADMINISTRATION, MANAGEMENT AND COORDINATION

The Ad Hoc Panel for Program Administration, Management and Coordination recommends the following:

Program objectives for FY 1979 should include:

1. Staffing of the NAWDEX Program Office should be increased to provide the management oversight vital to this rapidly expanding project. Support of the 112 member organizations and of organizations which are interested in becoming members requires effective interaction with the NAWDEX Program Office. Nationwide interest in NAWDEX is clearly demonstrated by the 62 organizations represented at this First Annual Membership Conference. To sustain the momentum of the program and to achieve the membership representation required for reaching NAWDEX goals, increased emphasis should be placed on publicizing the NAWDEX program; on developing policies, procedures and implementation strategies; and on documenting available data and sources. Continued effective leadership from the Program Office is needed to assure a viable national program.

2. Action should be taken to increase NAWDEX membership by:

A. Developing a slide and cassette presentation on the NAWDEX program. This presentation should be a slick, professional job, geared to local-level audiences. The flexibility of the Memorandum of Understanding must be stressed, perhaps by graphic means (such as a cartoon), and by using vivid colors.

B. Developing a videotape presentation, using the same approach as above, and perhaps using animation.

C. Promoting regional and statewide NAWDEX organizations and facilitating the membership of these organizations.

D. Urging present NAWDEX members to promote the NAWDEX concept among other prospective member organizations so as to heighten their interest in membership.

3. To provide guidance to the Program Manager, an Ad Hoc Advisory Group should be formed. This group should be made up of member representatives selected equally from each of the categories of NAWDEX member organizations: Federal, State, and local government; interstate; academic; and private. Foreign affiliates should be invited to attend the meetings. This group should meet approximately quarterly as required by the Executive Secretary and the Chairman. Travel expenses and subsistence should be paid by the NAWDEX Program Office as specified in "Program of Operation for the National Water Data Exchange (NAWDEX)," U.S. Geological Survey Open-File Report 77-708. The NAWDEX Program Manager should serve as Executive Secretary of this group. The group should select its own chairman. The

necessity for continuing this group should be reviewed by the full membership at the next NAWDEX membership meeting.

4. The subject of expansion of the role of NAWDEX in the area of data dissemination was discussed extensively. The panel concluded that the original NAWDEX concept should be continued as described in "Design Characteristics for a National System to Store, Retrieve, and Disseminate Water Data," U.S. Geological Survey, Office of Water Data Coordination, Washington, D.C., October 1971.

5. Member organizations should be encouraged to designate additional NAWDEX representatives consistent with their operations and organizational structure. The NAWDEX Program Office should be provided the names and mailing addresses of these additional representatives so that they can receive NAWDEX literature.

6. Specifications for indexing areal and nonpoint source data should be developed. These data are required to meet an identified need of a growing user community.

7. The Water Data Sources Directory should be improved and expanded. Particular emphasis should be placed on including major computerized data bases as an initial effort.

8. Member interaction in improving and expanding the Master Water Data Index should be encouraged. An appropriate training program to facilitate this objective should be established.

9. Automated capabilities for indexing computerized water data files of member organizations should be developed.

10. Software should be developed to make it possible to assemble summary information from the Master Water Data Index.

11. Major non-Federal NAWDEX members should be encouraged to become Local Assistance Centers.

12. Recommended standards for the handling and exchange of water data should be developed.

13. The NAWDEX Program Office should investigate the feasibility of implementing the UPGRADE system of the Council on Environmental Quality for use by Local Assistance Centers in providing service for NAWDEX users.

Membership conferences should continue to be held annually as described in "Program of Operation for the National Water Data Exchange (NAWDEX)," U.S. Geological Survey Open-File Report 77-708. The location should be varied to accommodate the participation of local members. An attempt should be made to reduce the duration of the conference to 2 days by reducing the number of papers to be presented. The format of working panels should be continued.

The membership should be given an opportunity to recommend subjects to be discussed by these working panels.

Submitted By:

Harold S. Lippmann, Chairman

Participants:

Harold S. Lippmann, Office of Hydrology, National Weather Service, NOAA
Jack R. Pickett, U.S. Water Resources Council
C. R. Baskin, Texas Natural Resources Information System
Nancy C. Lopez, U.S. Army Corps of Engineers
John W. Peel, U.S. Department of Energy
James M. Stewart, Southern Water Resources Research Institute, North Carolina State University
David F. Gudgel, Bureau of Reclamation
C. Lee Holt, Water Resources Division, U.S. Geological Survey
Bruce K. Gilbert, Water Resources Division, U.S. Geological Survey
David Pingry, University of Arizona, College of Business and Public Administration
Solomon M. Lang, Water Resources Division, U.S. Geological Survey
Doug Glysson, Water Resources Division, U.S. Geological Survey

NAWDEX Staff Support Personnel: M. D. Edwards, Program Manager, assisted by Loretta M. Warrick, USGS, WRD, Office of the Administrative Officer.

Panel 1. Program Administration, Management, and Coordination

DISCUSSION OF REPORTS PRESENTED BY THE AD HOC PANEL CHAIRMEN

[*Editor's Note: The following is a portion of the verbatim transcript of discussions held following the reports of the ad hoc panel chairmen. Some editing has been done to provide clarity and to delete procedural and irrelevant comments.*]

MR. LANG: I want to thank the panel chairmen for their reports. I propose that if there are any motions to be acted upon, or any formal adoptions to be made, we should wait until after we have our period of discussion.

I suggest that we go into some of the questions and comments. There are a number of items that have been presented to the group by the four panels, and I would like to get the reaction of the group to each of these work group reports.

I suggest we go back to the same sequence of reporting that we used earlier this morning, and the first report, Panel 4, was presented by John Wilson. John presented a number of items that cover the particular subject of request, response, and service activities, and the summary document that he gave me contains two major points. Let me read them one at a time, and perhaps we can have some discussion on each one and get some feel for what impact it might have on NAWDEX.

> "Some expansion of the NAWDEX Local Assistance Center network is warranted. The Program Office should be deliberate in the approach to such expansion, and high priority should be given to including State-level organizations which are operating information systems for water-related data."

I might say that, as far as the current program of NAWDEX is concerned, the objective is, of course, to expand the membership. Any ideas that you might have with respect to how we go about doing this would be helpful. I think Harold Lippmann also touched upon this in his report of the panel group on program administration. He had some specific ideas as to what methodology might be used in expanding membership. I just wonder if you have any comments, John, as to what Harold touched upon in this particular area.

MR. WILSON: (Texas Natural Resources Information System - TNRIS). I think the primary difference between Harold's comments and mine is that we feel a more deliberate approach to membership is needed. We shouldn't let the system get out of hand and overwhelm the Program Office. We feel that consideration should be given to State entities which provide a focal point in particular states for water-related data. I believe that is similar to what Harold has said.

MR. LIPPMANN: (National Weather Service, NOAA). I would like to point out that John, I think, is looking at this in terms of Local Assistance Centers, and we were approaching NAWDEX membership in general, two slightly different subjects.

MR. LANG: I agree. The encouragement of groups to act as Local Assistance Centers, of course, requires some direct approach, and I was just thinking of some of the techniques that you had mentioned as perhaps being appropriate. I get the feeling, though, John, you were saying that selection should be very deliberate.

MR. WILSON: Well, again, we're talking about Local Assistance Centers in our discussions, and Harold pointed that out. I believe in our panel the concensus was that it should be a deliberate attempt, so that we don't get too many centers in one particular area.

MR. LANG: Okay. I think you recommended that there be no more than two per state, is that right?

MR. WILSON: That was the recommendation, with the qualification that in some heavily populated areas where the demand for data is greatest and which are covered by regional offices of various Federal agencies who have a very large user constituency, that consideration be given to establishing three.

MR. LANG: Do you suggest that these be selected geographically?

MR. WILSON: Yes, they certainly should be, at least at the State level and possibly even lower than that, but I think initially at the State level.

MS. LOPEZ: (Corps of Engineers). I'm not from John's panel, but in terms of discussing how we might facilitate developing Local Assistance Centers, I think one of the things that is vital is that you provide NAWDEX technical assistance to the States that are interested in becoming data banks and developing this kind of activity; but in order to achieve that, the experience of the NAWDEX Program Office is a must, and one of our most important recommendations, we feel, is expanding the Program Office and the purposes to be served by that office, so that they can provide technical assistance to States that need help in establishing NAWDEX-type programs.

MR. NETHAWAY: (USGS, Denver Local Assistance Center). I think that the idea of having the State governments as Local Assistance Centers is quite good. Each of the 46 Survey offices provides access to WATSTORE, whereas, if each State had a Local Assistance Center established in a State agency as well, then they could directly access the State's data. Our USGS Local Assistance Center and the State Local Assistance Center would work together, such that when we get a request we can provide data from both systems.

MR. LANG: Does this presuppose that all of the State data banks, then, have to be indexed prior to their serving?

MR. NETHAWAY: I believe that the recommendations have come across that the State's data base point-source information would be indexed, ideally, with support and technical assistance from the Federal office.

MS. SVANDA: (Minnesota Pollution Control Agency). By default, we are doing this in Minnesota. The USGS office is in St. Paul, and they know me because of my affiliation with STORET, and requests that they get for local STORET data they will refer to me directly, and although my data is indexed, it would not have to be indexed for other States because the State contact would be familiar with the data.

MR. LANG: I think the concept of NAWDEX actually goes down to the Local Assistance Center as well. Remember what we were saying earlier that we have a focal point and that it is not necessarily that point at which the data will reside. As long as we have the contacts, the points to which we can go with the requests, I think we are then able to service the public. This has always been, I think, the basic mode of operation that we foresaw for NAWDEX. Does this perhaps modify the recommendation? Is is really necessary to have more than one Local Assistance Center at the State level?

MR. WILSON: I think the point that Mr. Nethaway brought out about getting the data into the system is important. In Texas we have, as I mentioned, a lot of State agencies with a lot of data. We, for one State, and Nebraska, Idaho, and some others, are putting together information systems to index and aggregate that data. In many States, the situation does not exist whereby you can get the necessary information by going to one agency. If you designate just one entity, you get their data and the data of the people they talk to, but you don't necessarily get water data from agencies with whom they are not in contact. So, I think getting the data into the Master Water Data Index is one important consideration with the Local Assistance Center program.

Secondly, let me discuss what we talked about in our panel session. Where possible, those organizations at the State level who aggregate, index, and disseminate data which are being developed, even if they are in the formative stages, should be solicited for their participation as NAWDEX Local Assistance Centers. In those States where State-level data aggregation does not exist or isn't likely to happen, other alternatives need to be looked at--possibly designation of another single State agency. In the smaller States maybe there is no need at all for a second center; maybe the USGS local office there can handle requests adequately.

MR. LANG: Any further comment?

MR. KNUDSEN: (Colorado Division of Water Resources). I think in any case where there is a recommendation to establish more Local Assistance Centers, particularly where you are talking about taking it out of the

Federal office and putting it into another State organization or whatever it might be, I think you should keep in mind that for any kind of recommendation like that the resources would have to be provided to do this sort of thing. It takes people and money to run those things, and many of the States don't always have the sympathy, let us say, of their legislators or other groups. Perhaps you may have the resources at the Federal level, but I think any kind of recommendation like that should also include something about providing the resources needed to do this. For example, in our office, we provide data to a wide variety of people in the State of Colorado and to others who come into the State looking for water resource information on Colorado, and to take on any additional burdens in that area could impose an impossible workload on the agency. This particular subject also came up in the Panel 2 discussions yesterday. We want to be able to provide it, but it may take extra people and extra money.

MR. LANG: What additional resources do you think would be needed--funding, manpower?

MR. KNUDSEN: I am assuming that when you talk about additional Local Assistance Centers, that you are talking about some sort of a communications hookup with NAWDEX. That would mean additional equipment to purchase and additional people to operate that particular equipment. It may even take an additional clerk to help service the information requests, when it becomes known that you are a Local Assistance Center. For example, in my experience with our data bank, when it becomes known more and more that such a thing exists, then people become interested in acquiring data from it, and you get overwhelmed by a large number of requests that have quite a variety of parameters built into them which you may or may not be able to handle.

MS. LOPEZ: I think well-established NAWDEX programs like those we've heard about this week, which could be documented to show the benefits of having this kind of system within the State, could serve as examples to help other States justify the expenses associated with centralizing access to State data bases. I think there is a management role that we can play in providing the type of information that will help other people help themselves in some programs.

MR. EDWARDS: I'd just like to make a couple of comments: Number 1, as I understand the recommendation, the existing Federal Local Assistance Centers or the existing non-Federal Local Assistance Centers, and any additional new centers which might be established, would work mutually supportive of each other. They would be working together; they would not necessarily work as a separate entity within the State boundaries. Also, one important thing we should not lose sight of is that it will be quite some time before NAWDEX can reach the national funding level whereby we can start providing hardware and financial support to the Local Assistance Center network. But as was specified in the program of operation, I do think that we need to be looking seriously at what we can do in the way of reimbursement of services. In fact, we should be thinking in terms of the Local Assistance Centers eventually becoming self-supporting. There is a lot to consider, but I think the whole idea of developing Local Assistance Centers in a self-supporting manner should not be lost in a discussion.

MR. KNUDSEN: We have a little experience there. I hope my comments aren't taken as negative because they aren't meant to be that way, but our funding is both a matter of a general fund and a cash fund, or "spending authority" as our State legislature puts it. And when you talk about being self-supporting, I certainly would agree that much of this should be self-supporting, because even though you are providing a service to users, there should be reimbursement for that. But, if you emphasize that too much, you are going to find yourself in a bind and the people who are authorizing the money to operate with are going to say, "Since you're going to be self-supporting, we're going to reduce your general fund appropriation each year and you can generate the additional funds required to operate your program." You might find yourself in a little bit of a bind.

MS. LOPEZ: I have a question here about what the concept of a Local Assistance Center really is. Is a Local Assistance Center supposed to be able to access any of the NAWDEX data bases? I somehow didn't think so, myself. I thought they would have some primary data accesses, and otherwise they would direct a user looking for data to the most appropriate source for obtaining it. I didn't think that a Local Assistance Center had to take on the whole workload for their area.

MR. LANG: That is what I meant when I said the concept for NAWDEX applies also to the Local Assistance Center, which is the focal point where the contacts can be made. The data does not have to be there.

MR. ROSS: (EPA, Region V). I have had experience with people who are users of data. They have been referred to me by the USGS for STORET data, but the Local Assistance Center in Champaign can also access STORET, so they can contact either one, USGS or STORET. They prefer that I stay with the STORET and if I absolutely have to, I will call them and ask them to please help me out with some of the USGS requests. In this way we are working together.

MR. NETHAWAY: When I supported the comment about each of the State governments having a Local Assistance Center, I did not want to associate that with their data bases, themselves; however, I think that the State personnel are more familiar with their data than a Survey person would be. We have seen and heard reports on how much data the State governments have--massive amounts of data--and so it seems like the combination of State and Federal Local Assistance Centers would be very advantageous. It seems to me that having Local Assistance Centers in such State facilities as the Texas Natural Resources Information System would be very advantageous.

MR. LANG: I'm trying to react to some of the comments you made. Unless the individual at the proposed State Local Assistance Center has access to the State data and has access to the individual files, how would he, essentially, be able to react any better than the current Local

Assistance Center. If it is not in the Master Water Data Index (MWDI) or the Water Data Sources Directory (WDSD), how do you respond to that? How do you know what point of contact should be made? That's why I asked the question at the beginning about the need--does it presuppose the indexing of those files?

MR. LANGFORD: (USGS - Office of Water Data Coordination). I think we need to recall that the indexing of files can be in the form of a rather general index or it can be a very specific index, and the two examples that were given, the Water Data Sources Directory and the Master Water Data Index, in my mind at least, reflect that hierachy.

And that leads me into the point that I wanted to make with regard to your work group report, John--and I think it was reflected in others as well--and that is the importance of the feedback mechanism. To me, this feedback is in two ways: One, the ability of the NAWDEX system to locate those agencies that have the data and get the user to them. But perhaps more important is whether or not the data are there to respond. It is that second feedback that concerns us all, I think, that we somehow identify--you could put it in these terms--the failure of the system to work because of data deficiencies, not information about data, but the data deficiencies, themselves. That's an extremely difficult thing to do. We tend to lose sight of that in the daily operations.

MR. LANG: I think that is an important point, but, the lack of information is an important piece of information also, just as knowing what data there are, so that I don't think, in the concept of NAWDEX, that we have really overlooked this; we recognize it.

I might just add this. When you talk about the Water Data Sources Directory and the Master Water Data Index, the thinking back at the time the concept was developed was that it would take a long time before we really have a fully-effective Master Water Data Index. That is where the Water Data Sources Directory concept came in. Until such time as you can get around to doing the indexing, you have the general overview of an organization's activities so that, even though you don't have the specifics, you have a general idea of the areas where it is active. So, they are both complimentary systems. I don't look upon them as hierarchical, as you state. One, of course, is more intensive than the other, but I think from the standpoint of the operation of NAWDEX, they parallel each other; they are equally important.

(A short intermission was taken at approximately 10:00 a.m.).

MR. LANG: Prior to our break, we completed the discussions of the point that was made by Work Group 4 on the expansion of Local Assistance Centers. They have a second significant finding that I'd like to present to you at this time and open up for discussion. Let me read this to you: "It is further recommended that NAWDEX provide additional capabilities and services from the Master Water Data Index and Water Data Sources Directory."

It seems that you have made several points, actually, in this one paragraph. When you talk about additional capabilities and services, is there some way perhaps that we can deal more specifically with what you had in mind?

MR. WILSON: Well, in that paragraph, we go on to say that within the Master Water Data Index that there should be a reference or cross-reference between data files that are in the system and the output products that the holder of the data has the capability to generate. It would seem to be very good to know whether you can get a tape copy, or whether you can selectively get punch cards from the system for State-level use. In addition, output products, such as microfilm for larger printouts for selecting large amounts of data, would be very appropriate as would other capabilities of that nature.

MR. LANG: You specifically refer to output microform to cut costs associated with the printing and mailing of large reports. Of course, this raises the question of whether the recipients of this information are equipped to really handle that kind of output. So, as you say, this is a selective service that would be announced, and if they want it in that format, they could request it.

MR. WILSON: It would be tied to the particular data file in the Master Water Data Index, so that the person who was requesting available data could also find out in what form it could be obtained. Then he could selectively figure out which form would be most appropriate for him--printed copy, microfilm, or whatever.

MR. EDWARDS: (NAWDEX Program Manager). There already is a specific coding capability of the Master Water Data Index that indicates in what forms data are available for each repeating group, whether it is computerized, published, microform, or a combination of these, and, if there is nothing there, we assume that it is available in raw form.

MR. WILSON: I think maybe we could modify our recommendation to suggest that we expand that a bit and find out whether we can get graphic output--computer generated plots from the bank.

MR. EDWARDS: Okay.

MR. LANG: If there is no further comment with respect to the Panel 4 report, we will go on to the next one which is the Panel 2 report that was prepared under the leadership of Walt Knudsen, and which has to do with the standards for handling and exchange of water data.

They gave me four significant findings and recommendations: Number one, I think, Walt emphasized several times in the report that the term "method" be used in lieu of "standards". I think this perhaps is an appropriate comment because what is a standard to one person or group does not necessarily have the same meaning to someone else. I think from the standpoint of recommended methods or recommended procedures, you can cover the same area without the same connotation that the word standards carries with it. I don't think there is a need for much discussion on that point.

Number two is that NAWDEX and OWDC jointly establish a working group from NAWDEX members and other organizations by September 1, 1978, to develop recommended optimal methods for the handling and exchange of water-related data.

MR. JOHNSON: (USGS - Office of Water Data Coordination). This was recommended with the idea that it would be an additional working group on the organizational setup like what we already have, and membership would be selected as the panel points out.

MR. GLYSSON: (USGS, Menlo Park, Calif.). Are you talking about having this as a Chapter 11 of the National Handbook of Recommended Methods or as a separate publication?

MR. JOHNSON: As a possible chapter, but that would be something which the work group would decide.

MR. THOMPSON: (NAWDEX Program Office). During our discussions, the details of how this would be accomplished really were not gone into, and a discussion of whether or not it would become a separate type of publication, or a chapter, was not touched upon with any significance. So, I think the intent was that once the group was established, they would probably determine in what format this type of thing would be published or distributed.

MR. LANG: I am just wondering, since the current operation is under the banner of two advisory groups, whether we could just go ahead and create another one without going through the whole procedure of asking their review and input, and whether this might become a much more involved situation than, perhaps, we would like to see at this time. Since it is a problem of data handling and an exchange of water data more so than just methodology for acquisition of data, I also question whether it is advisable to put it into that same framework that you have for the other 10 groups. Of course, if this is made part of the final report, then, of course, we will give further consideration to it.

MS. LOPEZ: (Corps of Engineers). Because of the complexity of the issue of organizations, we might want to remove the deadline of September from that recommendation for establishing such a committee. There may not be enough time to achieve this goal within that deadline.

MR. KNUDSEN: (Colorado Division of Water Resources). We know that the problem we are looking at is quite a good-sized one. With all the conversations that we had, we didn't feel that we could give much in the way of specific details on it, so that is why we went to this particular method, which would be to establish a continuing working group.

The date that we chose, September 1, 1978, wasn't pulled out of a hat. We had consultations with both Jerry Thompson and Ivan Johnson, and both felt that it was a reasonable date for establishing a working group. They may change their minds afterwards. The other thing that the group came up with in respect to organization was that there should be a progress report by the working group at the next meeting, rather than just a report on the organization of the group. We want to have a group organized to do something, but at the same time, we want them to have something done by the time the next meeting is held, other than perhaps just being organized, although that, in itself, may be a good-sized problem.

MR. EDWARDS: (NAWDEX Program Office). I would like to make a couple of comments about committees. There have been two specific groups recommended for formulation this morning: one, an ad hoc steering committee or an ad hoc steering panel; the other, a panel for the development of recommended methods for data handling and exchange. We have been concerned about this in the Program Office from the very beginning. That is why the program of operation stated specifically that in regard to formulation of committees, ad hoc working groups, and so forth--I have to adhere strictly to the rules and regulations of the Department of the Interior.

I have been in conversation on several occasions with Ivan Johnson and Hal Langford of the Office of Water Data Coordination, specifically, anticipating that some of these types of things were going to come out of this conference, in terms of trying to utilize the existing structure of both the Federal and non-Federal advisory committees, within OWDC, as possible bases of operation for the formulation of some of these activities. This would create one specific problem for us, because those two committees are very clearly delineated on both a Federal and non-Federal structure, whereas the National Water Data Exchange is not. We are not clearly defined along these areas in the operation of our membership. I think perhaps we can accomplish that with the standards activity rather simply. I do have some concerns over the steering panel. We will go back and take a close look at this and see what the problems may be, but I would like to make you aware that I think we will be able to accomplish what has come out of the recommendations this morning. However, the final product or the end result may not be exactly as you might anticipate it to be.

MR. LANG: I might throw a question to Doug Edwards along this line, then. We still do have the working group on data handling. It is still in existence. Could this panel form the basis for some of the activity that we are talking about here--invite participation from the membership group on some of their activities or meetings?

MR. EDWARDS: I think that is true. I think the title and the charter of that committee is appropriate. It is still in existence although they have not been active for about 2 years. We do have the immediate problem that it is identified as a Federal committee. That may create some problems.

MR. JOHNSON: (OWDC, USGS). I see no problem at all in having an intermix of non-Federal and Federal personnel on a working group, as long as they are willing to serve, and it is tied into this. We are using non-Federal people already in developing the methods, by drawing them in through the non-Federal working group that is the advisory group to the other 10 technical working groups. We have nearly 100 people there that are drawn on for review. In this case, with your standards--data handling standards, you might substitute for those 100 people that were brought in for that particular thing, and for their expertise, say, the membership of NAWDEX as the reviewers, so that everybody gets a chance.

MR. LANG: The next recommendation actually is a carryover from the second one in that the '79 NAWDEX membership meeting should include a report from that working group. Again, I guess until we resolve the question as to how we can go about setting up these working groups, that would be very much impacted. The items that the working group should address, I think, are interesting. One item is common codes. I hesitate in trying to comment on that. When you talk about common codes, the first thing that pops into my mind is the parameter codes, such as EPA uses with STORET. Is that what you have in mind when you are talking about common codes?

MR. THOMPSON: (USGS, NAWDEX). I paraphrase that when I use it on different codes--fixed codes.

MR. LANG: Okay. Codes that are already established and are being offered by a central system like FIPS (Federal Information Processing Standards). The next is data accessibility. Would you like to comment on that Walt, as to exactly what you had in mind there?

MR. KNUDSEN: If I remember the conversation at that time, it was really divided into two different parts, and I think that particular topic was related to how the data were stored. Was it actually in some sort of a formal type report, or was it just in some sort of working documents that were filed away in a drawer? Was it actually available on the computer? So, it really boils down to identifying the access availability of the data.

MR. LANG: How would the data group essentially tackle this particular subject?

MR. KNUDSEN: It would delve into the area of standards in identifying the accessibility of the data within NAWDEX. Is there some sort of a code, if you wish, that can identify what we are dealing with.

In other words, if someone contacts me with respect to the data that we have in our office--what is the availability of that data? For example, in our office, we maintain some gaging stations that are not part of the USGS network. It is not published data. It exists only on a chart, so if someone wants to use that data, they are actually going to have to look at the charts. The USGS gaging station data can be obtained in a computer-readable format or in hard copy. We need to identify how data exist.

MR. WILSON: (TNRIS). It sounds like what you are getting at, Walt, is about the same recommedation that my committee had, except taking it further and having some specific categories of published information, such as where you can get xeroxed copies or get copies of the publication if it is in that form.

MR. WEBB: (CACI, Inc.). That information already exists in the Master Water Data Index for everything that is indexed. It may not be a broad enough, or specific enough, category, but this capability does exist.

MR. KNUDSEN: We may be falling into the same trap, so to speak, that John did, when he made recommendations only to find that they are already implemented, therefore, indicating we didn't do our homework.

MR. LANG: No, it is not necessarily that. The term "data accessibility" has a broad meaning, and unless you can narrow it down to some workable size, it is a little difficult to really handle it. For example, I talk about data accessibility and you can right off say, "Well, should our machine files be directly accessible?" To some degree, we do some of that, but can other agencies, essentially, accomodate that same approach. So, when you talk about this particular topic, different thoughts pop into people's minds, and I am just trying to get some clarification as to what the work group was recommending here.

MR. KNUDSEN: All of those thoughts were in our minds and that is why we couldn't come to any consensus of opinion, so that needs to be looked at.

MR. LANG: Further comment?

MR. NETHAWAY: (USGS District Office, Colorado). I presume this committee is looking at the exchange of data, itself, not just indexing. Concerning common codes, I wanted to make a comment that not only are the FIPS codes important but I think that it is critical if we are going to machine transfer--computerized transfer of data--to have things like the EPA's parameter codes agree with Survey parameter codes; accuracy codes agree with accuracy codes and so forth. It is quite a job to tackle, but I think that if, nationally, the water data exchange needs to adopt those standards, then the committees have a very hard task in front of them. Otherwise, if we receive data from some other agency, we do have to make the personal custom conversion of their data. That would also include metrication, and so on.

MR. THOMPSON: (NAWDEX Program Office). Our panel went through quite a struggle in attempting to look at what might facilitate an easier method of transferring data, no matter what its form, either in a file, or magnetic file, or a manual file. We approached the subject of codes that was just mentioned. We immediately got this type of reaction--that an individual State's data base may have its own set of codes, which is not the same as FIPS. What I am trying to point out is that the people concerned were well aware of the impact it might have if we were to say, "There are certain standards that you could use when you set up your data base." This is one reason why we changed the idea of using a method, because we did not want to suggest in any way that we are going to impose standards. I think that was one of the reasons why we felt that a study group could go into this in a little more length and detail, and kick the subject around so that the impact on those organizations whose codes and systems do not conform to the methods that will be recommended could be reduced as much as possible.

MR. PICKETT: (U.S. Water Resources Council). When we start analyzing this, I believe what we are really after is some kind of a standard type of information for transferring information into a data base. The advantage of that standard is that all the various States with their different ways of doing things, all the agencies with their special needs, would have one common conversion to go through in transporting the data out or bringing somebody else's in on comparable terms for their own data base structure. I think this is where the value would be. In time, a standard would apply to some of these data bases--would cover conversions first in our design. But initially, consider it to be a standard or a method for transferring data between the various data base structures.

MR. LANG: Thank you, Jack. Any other comment?

MR. LANGFORD: With regard to Walt's report, I took some notes to the effect that the committee, or working group, recommending the setup would consist only of NAWDEX members. Did I hear that correctly?

MR. WILSON: (TNRIS). No. I have just one question. I am getting a little bit confused about this standards deal. A question was asked earlier about whether consideration was being given to taking parameters that don't already exist and coming up with standard codes for them. Are we talking here about coming up with some codes that might contradict what other Federal agencies have done, or are we talking about expanding on what they already have.

MR. LANG: I got the impression that they are talking about identifying codes that already exist that could be accommodated within the system. Not only FIPS, but you have ANSI (American National Standards Institute). There are a number of ANSI codes. There are some ISO (International Standardization Organization) codes that have to do with data representations and transmissions. So, there are a number of existing standards, and there are standards being developed right now that would impact on the work that is being done. I am active in one of the ANSI groups on data representation. I know that there are several standards being worked on right now that could have some impact on this group. The next item that was mentioned in the panel report was site identification. I know this particular item is a real problem, and it is one that we have been trying to deal with for a long, long time. Here, again, are we talking about a site ID that would be added as a NAWDEX ID beyond what is already in the system?

MR. KNUDSEN: No, I think what we are referring to here is not so much whether there is some sort of a NAWDEX ID as to having some sort of recommended method for identifying your sites within the NAWDEX system. Maybe I could give an example. There are a number of different ways that one can locate a site ID. Everybody talks about latitude and longitude. We could also go to a hydrologic unit code. In Colorado, we have within our water rights data base, a legal location. Yet, when we talk about our diversion structures, we are talking about our various and sundry water divisions, water districts, and locations on streams. And I think I mentioned one of the things that we hope we will put in sometime which is stream miles. There could be any number of ways in which a site could be located, and the idea here would be to look at some methods of identifying them, and then be able to identify what method is used in the NAWDEX index, so that when someone is looking through there they know what kind of information they are going to be dealing with.

MR. LANG: Excuse me, but you are using two terms. I am just wondering if you are using them synonymously. You are using ID and you are using locations. Are you talking about locations, really, more than ID?

MR. KNUDSEN: Yes. When I talk about site ID, my comments are prejudiced because I am thinking of a particular number we have assigned to our various structures.

MR. LANG: Again, the way you just described it, that is an ID and not a locator, necessarily. I am trying to clarify just what the committee was really referring to, because there are a number of ways of locating a point, as you all mention, but when you come down to an ID, where it has to be unique to that particular system, then it is a different ball game. There are a number of systems that are being used for IDs. Within the Survey we, essentially, have two basic ones. We have the downstream order number for on-stream sites, which is an 8-character numeric code, and we have a latitute-longitude 15-character code for off-stream sites. I guess if you went from one agency to another, you would find many different IDs that are being used, and I remember when we were talking about the NAWDEX concept and NAWDEX needs, we talked about the need for an ID, but we could not come to an agreement with the various agencies as to, specifically, what that ID should entail. I don't know if you are going to be going over the same ground here, but I definitely think some new thoughts might evolve from this and might clarify the situation to some degree.

MR. LANG: The next subject of Panel 2 was "Multiplicity of Common Data Exchange Formats." Do you want to expand on that a little bit?

MR. KNUDSEN: I think that is referring more to machine-readable format, and we got into quite a discussion as to what might be the responsibility of the collector and storer of data versus the responsibility of the user of the data. Since we are all operating on a wide variety of machines, and systems, we wondered what we could do to ease the burden of going from one machine to another? Again, we get back to the matter of resources. Whose responsibility is it? Is it the responsibility of the collector and storer of data to give the user exactly what he or she needs for their particular machine, or is it the responsibility of the user to take what he gets and convert it to fit his needs?

MR. LANG: The idea here is to see if we can find some relatively common ways so that you have a variety of methods for transferring the data. We had an example with the USGS and their gaging station data that is available in one of three or four different formats, so that it makes it relatively easy to go from one machine to another.

MR. ROSS: (EPA). How many times have you had the same latitude and longitude for the same location? I have never had this happen.

MR. LANG: We have a sequence number, that is, the 14th and 15th characters are a unique number that we assigned so that there will be uniqueness for the particular site. So, we can go up to 99 units within a one-second quadrangle.

MR. ROSS: So, you don't have conflicts?

MR. LANG: Right. We recognize that this occurs at times, when an error is made in the assignment of latitude and longitude, but once the number is assigned as an ID, we don't change that number. We have another field in our system that is the locator, and is latitude and longitude. Now, we will change that whenever we have need to change it. But the ID remains, essentially, inviolate.

MR. KNUDSEN: We are also dealing with a wide variety of data, and every time you look at it, it gets bigger and bigger. I think someone used the example that water quality data started off with about 40 or so parameters, and now, I guess, there are over 200, or something like that.

A VOICE: 2,000.

MR. KNUDSEN: 2,000? Okay.

MR. LANG: The last item that you had was "Identified Accepted Standards." Do you want to substitute the word "methods" for "standards" in this case, as well, or are you really talking about standards here?

MR. KNUDSEN: Well, probably more in the way of standards in the sense that there was a predominance of people interested in water quality standards. That is the thing that came up the most, although it could be transferred to other types of data also. I speak from a lack of knowledge, but it was my understanding with the group that there is a wide variety of water quality "standards or methods" of analysis or whatever you want to call it. Anything that the group looks at, they would have to start a study. They would look into all the various kinds of standards that are available to see if they could get some more common usage of the methods that are available.

MR. LANG: Are you talking about something similar to what is being done by the other group who are coming up with their recommended methods. Ivan, do you want to comment on this?

MR. JOHNSON: (OWDC, USGS). No, I don't really think so. He is just talking about any other data-handling standards, and not methods themselves.

MR. LANG: Are you talking about data acquisition methods, now? This is what I want to get clarified here as to what is being considered?

MR. KNUDSEN: I am not sure what you mean necessarily by data acquisition. I don't think we are getting to the point of how you are going to dip a bottle into a stream of water, but more so, how you are going to analyze what you have. Maybe Kathy can expand on that.

MS. SVANDA: (Minnesota Pollution Control Agency). The concern was--and this applies to data that was being used mostly in the mathematical models, because some of them have to get very technical--on how the data was collected and analyzed, but not that we, as a committee, or any work group that has been set up, would endorse methods, but rather endorse the handbook that is being done. This, I think, goes back to the index, to flag that data that was being analyzed in one of the approved manners.

MR. EDWARDS: A quality assurance indicator?

MS. SVANDA: Some way of indicating that a quality assurance was followed for those particular samples.

MR. LANG: Essentially, you are just saying you are going to flag methodology. We could get into a hassle on whether that is quality assurance.

MR. JOHNSON: It is better than no quality at all.

MR. LANG: If just a flagging of methods is used, to some people, this does carry some indication of quality, but you can have a methodology, and if it is used poorly, you can have poor data resulting from it. So, you do have some problem areas even along with that. Now, when you are talking about, again, the flagging operation, would this be a specific code that would be developed by the work group? Is this what you are suggesting?

MR. KNUDSEN: Yes.

MR. LANG: So, they would have to have a fairly detailed knowledge of what the recommended methods committee might be doing as well as some of the other methodology. I get the understanding, also, that you are not trying to identify each specific technique, but to just indicate whether it is either approved or--I won't say disapproved, but it is not one of the recommended methods.

MR. KNUDSEN: I think the easiest way to summarize it is that the panel was very concerned about trying to identify the quality acceptance of what you are getting so that you know how to use and analyze the data. You should be able to have some reasonable confidence in what you are stating as a result of your analysis.

MR. LANG: Okay. It is an added piece of information that might be of value to the potential user.

MR. KNUDSEN: That seemed to be of considerable value to the people who were talking about this matter.

MR. NETHAWAY: (USGS District Office, Colorado). It occurs to me on the data exchange, it will be a long time before the provider and the receiver of the data implement exchange-type codes. It is probably many years away, but perhaps now, in NAWDEX, we could identify the computer on which machine-readable output could exist. Or, we could identify the type of code that would typically be provided. For instance, the USGS in Reston has an IBM 370, that could be a code. The Bureau of Reclamation has a Cybar computer that could be a code. So, I know that we already have a code indicating the media in which data can be provided, but, perhaps, that could be expanded or another flag be put in there. But the computer, of course, could look at the results of an MWDI pull, or a WDSD pull, and say, well, they've got the data on a 370.

MR. LANG: What happens when you change your computer?

MR. NETHAWAY: You update your file. You don't change the computer that often.

MR. LANG: No, but if you've got a massive file, it is an involved procedure.

MR. NETHAWAY: I understand that. This is just a suggestion that might be fairly easy to implement because a uniform method of transfer is not going to be easy to implement. A flag about what does exist might be easier for now.

MR. PICKETT: (U.S. Water Resources Council). Concerning the unit code, the question I have is whether you are going to use that to restrict what data you are going to sample, or is that just supplementary instead of a phone call? If the data is stored in two places, and it obviously is stored in many places, there is a lot of redundant storage. If one person is storing it on a computer that is more easily used by my computer, then I can, perhaps, pull it from that source rather than the more difficult source.

MR. LANG: Doug, would you like to comment to some degree on what is incorporated in the Water Data Sources Directory as to this particular area? Isn't there something in there that indicates who, besides the original collector, has the data and where contacts might be made?

MR. EDWARDS: (NAWDEX Program Office). Essentially, the Water Data Sources Directory allows you to identify anything you would like to identify. There are several capabilities in the Water Data Sources Directory that allow you to do these types of things very quickly. There is a portion of the Directory that does identify other sources of an organization's data. This was done specifically to allow us to try to cross-track data that may be transported from one system to another.

One of the things that is very significant about the Water Data Sources Directory is that we recognized very early that there was going to be a need to identify a lot of information that might be unique to a particular organization, or a particular system. So, we added an extensive comment capability, whereby your organization can identify in a textual manner, the computers that you are using, perhaps the programming language that your software is written in, statements as to what your policy on charges are, or even whether or not you will respond to requests for data.

There is a lot of extensive open-end, free-field type of capability within the Water Data Sources Directory whereby we can very quickly implement a lot of the things that we are talking about here today. If you are not familiar with the Water Data Sources Directory, you might want to take a look at the data dictionary just issued by the Program Office to all the membership, which, essentially, gives a brief description of every component that exists in the Water Data Sources Directory, as well as a schematic definition of the structure of the data base, itself.

MR. LANG: Thank you. If there are no other comments with respect to this work group report, we will proceed to the report of Panel 3, which is Water Data Indexing and Technical Services Development, headed up by Dick Talcott, Iowa Water Resources Data System. We will go through the panel suggestions one at a time, so that there will be an opportunity to comment on them.

Suggestion No. 1: System documentation should be synthesized and careful attention given to an expanded training program and assistance to new members, as well as to new Local Assistance Centers. Does that need any clarification?

MR. EDWARDS: (NAWDEX Program Office). I would like a clarification of what you mean by synthesizing the documentation.

MR. TALCOTT: With all the documents, and there were something like 27 documents sent to members of the panel, and several additional ones provided to us when we arrived here, many people who are new to NAWDEX still have a hard time realizing that NAWDEX indexes data but it does not store data in a data base. And that is an example of how important it is to get an overview of just what NAWDEX is. Perhaps we need a more formal document, or an organization, or a system for transmitting the materials that will give the novice the information that he needs to know to react to it.

By "synthesis" we mean a summary. It is very difficult to do, I realize, but one document, or a notebook, is needed that would take people through the whole body of material that they receive. And our solution was to expand the training and coordinate the training activities with the provisions of this documentation.

MR. LANG: Suggestion No. 2: New data bases to be indexed should be selected on the basis of priorities established through polling of potential users. The system should be modified to allow locational referencing for linear (river-reach and areal base) data. Is there any need for clarification on that one?

(No Response).

MR. LANG: The third suggestion is: Inducements, for example, in the form of potential benefits to members, should be provided to encourage voluntary participation in indexing. I will ask for verification on that one. What do you mean by the form of inducements?

MR. TALCOTT: Well, that is a little bit of my own philosophy. I believe that some of the decisions we are trying to make about organization, management, services, and data base extensions, and things like that should be very closely related to application needs that are expressed by members. In the absence of distributing funds to members for participation in NAWDEX, we are going to have to identify clients that have applications and respond to their specific needs, so that in almost immediate return for their effort and participation they have some benefit--that is, they can now use the services of NAWDEX when otherwise they would not have been able to use them.

MR. LANG: You talk about potential benefits. Do you have anything specifically in mind that could be added to what benefits are already available?

MR. TALCOTT: I don't know if it is a very good example, but I think most States have restricted, protective flow requirements on streams. They decide what flow rate on streams is minimim for protection of your interests. In dry years, they will restrict withdrawal or diversion of the water from those streams.

Conservation agencies, on the other hand, are interested in protecting the quality of life and so forth. So, the question of what is the proper protective flow is fairly complicated. But there is some technical assistance available from the Fish and Wildlife Service, on the Federal level. It is a methodological type of thing. And if the Local Assistance Center was aware of the methodology that was available, as well as the various kinds of data that would be required, and if both of those things were indexed, then that would be an application, that would be a use--a query for NAWDEX. It has been hard for me to think of examples with my own system, but the idea is to take a kind of scenario approach. If we expanded our data base in this way, what kind of increased patronage would we expect? If we spend a lot of interaction with members, and become acquainted with their needs, it will help us have priority for the extension of NAWDEX services or extension of the data base.

MR. LANG: The next item states "It is not necessarily practical for NAWDEX to provide access to the data bases it indexes and/or is affiliated with." You all agree with that one, I assume.

The next suggestion is, "Priorities for allocation of increased funding should tend heavily towards users' needs, especially for technology--I am assuming that is technology transfer--field assistance, and index expansion to include data bases that users agree are needed to increase NAWDEX's patronage." To some degree, it sounds like an extension of what you were talking about before.

MS. LOPEZ: (Corps of Engineers). Can we move back to the recommendation just before this one? I was a little hesitant, but I decided I would like to add a little modifier at the end of that sentence. Could you please read it for me again? It is the one about being practical to access.

MR. LANG: Okay. "It is not necessarily practical for NAWDEX to provide access to data bases it indexes and/or is affiliated with."

MS. LOPEZ: I think if we leave that we are going to have a conflict of recommendations from different panels. So, maybe we ought to modify that to say, "but in some cases, it may be advantageous." I would like to cite STORET as an example. I would hope the recommendations would not indicate that statement to be the general attitude of the membership, because I think there is a significant membership that doesn't have that attitude. Thank you.

MR. REID: (North Dakota Regional Environmental Assessment Program). I am glad Nancy brought up that question because I have had some concerns all along here. I hope that these recommendations are not necessarily a reflection of this whole group because we haven't had time to think about them. It is important to sit down and look at the recommendations in writing and think about the implications. I am just curious as to how you are going to handle this.

MR. LANG: Well, we have a document that will be prepared in draft form that will go out especially to the chairmen of these work groups, so that they can take another look at what their recommendations entail, and decide if they need to make some modifications to them. And then, after that review is made, we will prepare the summary for the meeting itself. Even then, it does not necessarily mean that what is in that summary reflects the entire thinking of the NAWDEX membership. We still, of course, need time to review what these recommendations entail, as far as our operations. For example, it is nice to say we must increase the resources for NAWDEX. It is not that easy to do unless we can convince Congress to give us the additional money to support it; not only the money, but to come through with the additional personnel slots that we need to accomplish the job. So we look at these recommendations in that light. We need to do something about it, but what can be done, within a certain time frame, is something that will have to await the more practical requirements or impacts that others can impose upon us.

MR. EDWARDS: (NAWDEX Program Office). I would like to elaborate a little bit on that. I think there are a couple of mechanisms that will allow us to do the things that you are talking about. Number one, the conference proceedings will be distributed as soon as possible. That will give you an opportunity to look at the textual presentations of the committee chairmen, and so forth. You will have an opportunity to respond to the proceedings at that time. Also, you are going to see some of the things we are talking about here today reflected in the program objectives for Fiscal Year 1979, which will be distributed to the membership within 60 days. So any recommendations that do come up that you feel might have a severe impact on your operations could be delayed, or perhaps other things should be accelerated. You will have an opportunity to comment at that time on some of these items.

Some of the other recommendations here, of course, are going to take a considerable amount of time to get underway, so I think that in many cases there is nothing here that you can expect the Program Office to rush back to Reston and implement immediately. I think you will have sufficient time on an individual basis to respond to the Program Office with your comments on the entire proceedings.

MR. LIPPMANN: (National Weather Service, NOAA). I would like to remind the chairman and the members present that it was the desire of the Panel on Program Administration, Management, and Coordination that the entire membership present here voice approval of this report. We had a particular reason for this. We wanted the complete backing of the membership on our recommendations at this time.

MR. LANG: I think, from what John has been saying, that he would like to have the additional time to review this before endorsing the report.

MR. TALCOTT: I would like to agree with that. I was very impressed by the committee report and am, in general, in agreement with the recommendations that were made, but as is probably obvious, our committee worked from different assumptions about the level of consensus that was going to be reached by the panel. Our objective was to present the diversity of comment and suggestions nominally within our topic area and we didn't specifically discourage comments and suggestions in other areas. We felt that--or rather I felt that--we wanted to get as much communication from individuals, in an organized way, to the Program Office.

As a membership group, we don't have a charter. We don't have any rules by which to make decisions or treat a consensus. I don't feel it is justified at this time for us to make a formal resolution that would bind the Program Office to a specific set of recommendations. That doesn't mean that we shouldn't do it. I think we can do it very soon, but there are too many questions about the formation, sponsorship, and organization of the committee to make those recommendations and we need to resolve those first.

MS. LOPEZ: It was a feeling of our committee that in order to be able to decide what needs to be done, some group had to do it. At some point, you had to start with the Program Office. At the present time, the staff at the Program Office doesn't appear to be large enough to handle a lot of the ideas that appear to be pretty much the consensus of the group--for instance, expanding the membership and increasing the indexing capabilities. I don't see how we can disband as members and leave all these issues at the same point they are at now. If there is consensus on some of the issues, I think that it would be better to try to express that consensus so that work can move ahead. Otherwise, we won't have accomplished much, and the Program Office will be in the same shape as it was before the conference, except that it has informal feedback without any indication from the group of any kind of consensus. They won't really have the guidance from us on things they seek from this conference.

I would hope that we could go through those items expressed by our panel in particular and, on the ones that we do feel like we could act on, I would hope that we would do so as I think they are pretty critical to the program. And I also agree that there are a lot of areas where we would like to delay making a consensus.

MR. TALCOTT: My concern is, I think, a practical one. If you have an identification of the issues that are important to the members, and if you have a discussion of those issues and a general feeling about that, I think that is valuable. I am not sure how much additional value there is in trying to force a consensus on specific items. It would require a great deal of negotiation effort.

MR. LANG: I support your viewpoints to the extent that people were assigned to certain working groups, not necessarily that they may not have been interested in more than one. Because of that greater interest, to present the recommendations so quickly without really having a chance to absorb what they entail may not be fair to the membership.

MR. LANGFORD: (USGS-OWDC). I think it would be impossible to arrive at a consensus here today inasmuch as there are not enough members participating in this conference, not today anyway. The members of the Geological Survey who are here--and there's quite a few of them throughout the audience--really should not be participating in any such consensus. We are here to listen to what the NAWDEX members and NAWDEX users think. We have a long history on these advisory committees, both Federal and non-Federal, for the A-67 activity, and, believe me, I can assure you that we will consider these recommendations very carefully. We will also consider very carefully the comments that have been made in this session about those recommendations. And I think that we would give them as much consideration, in that process, as we would if some kind of a formal vote were taken. That is my own feeling about the situation here today. I can appreciate your views on that.

MR. LIPPMANN: (National Weather Service, NOAA). Mr. Chairman, we still feel that there are recommendations in our report which are of prime and fundamental importance and we would like to achieve a consensus of at least the representatives of the NAWDEX members present and put it in the record that these members are of this opinion on, at least, specific items in the report.

MR. TALCOTT: I submit that all the committee findings should be treated equally in that regard then, and I don't think that our committee is ready to submit our recommendations for a vote.

MS. LOPEZ: Mr. Chairman, there is a motion on the floor to accept those recommendations.

MR. LANG: Is there any further discussion?

MR. SKIMIN: (Great Lakes Basin Commission). Are there any procedures established for formal adoption of recommendations by the membership? Do we constitute a quorum right now?

MS. LOPEZ: No, there aren't.

MR. LANG: You are introducing elements here that perhaps should have been given additional thought prior to the meeting. We are reaching the stage where we find that time is running out, and yet we are being pressed for some concrete decisions on this. I don't think we are at the point where we can make these kinds of concrete decisions.

MS. LOPEZ: Then is it the consensus of the group that the decisions, such as the ones we are proposing, should be delayed until the next membership conference? I hope that is not the decision.

MR. LANG: No, we are not saying that at all. I would endorse what Mr. Langford said before, that all of these recommendations will be given serious consideration and we will try to act on them as best we can during the period between now and the next meeting.

MR. SKIMIN: Isn't the purpose of these recommendations, though, to provide input in formulating the program objectives for next year? So, really, these concerns will be expressed in the program objectives which members will review, so that they will cancel them when they come up for a vote, or some kind of acceptance proceedings.

MR. LANG: I thought Doug touched upon this before, when he mentioned that some of the outcome of this meeting will be reflected in the work plan that he is currently preparing.

MR. BURFORD: (Science Education Admin.--USDA). I am just wondering about asking Doug this question on what would he do, regardless--I mean, whether these things are voted on and approved at this meeting or whether they are not. Aren't they going to receive the same treatment?

MR. LANG: We still have to go through the same procedure, which they will have to go through--the review process. We still have to review the available resources and make the decisions on that basis.

MR. EDWARDS: I think there is an attempt to set a precedent here and perhaps in future conferences, to assure a mechanism for the adoption of formal resolutions from the membership. Am I misinterpreting that?

MR. LIPPMANN: I think so. I believe that our panel recognized that these are only recommendations and all we were trying to achieve was to make sure that it was on the record that the representatives of the NAWDEX members present here, approved specific items. We are particularly concerned with our first recommendation, and that is of staffing the NAWDEX Program Office. We want it particularly understood that we want an expression in the record that the members present recommended the expansion of the NAWDEX Program Office. If we only get that approved by all the members here, we will be very happy.

MR. TALCOTT: The motion that is before us presents some conflicts among the committees, and so even though I agree that the precedent should be set, I would have to suggest that a modified motion be entertained that would accomplish a similar purpose without requiring consensus and resolution of the conflicting statements that were made by the Lippmann committee.

MR. LANG: How many members do we have here?

(Show of hands.)

MR. LANG: I see approximately 15. So we have a representation of 15 members out of 112.

MS. LOPEZ: Let the record show there were 15 members present at the conference.

MR. LANG: Well, everything we are talking about will be on the record. That is why I also assure Harold that the report of his work group definitely will be in the record, and we definitely will be reviewing those recommendations.

MR. NETHAWAY: (USGS). Since there are only 15 members here, 10 percent or so, Doug could you clarify how the proposals for next year's program are actually done--just very briefly. Also perhaps you could send out a brief summary of these reports at that time so the people who never were here at this conference, might either support or reject findings of the conference. It does seem like 15 is a fairly slim amount.

MR. EDWARDS: That is a good suggestion. We could include, as a part of the program objectives for Fiscal Year 1979, an abstract of the reports of these committees, perhaps an outline of the recommendations could be made. Perhaps that is a good mechanism for at least getting the recommendations of the panels out to the total membership very quickly. That is a very good suggestion.

MR. GIDDINGS: (North Dakota Regional Environmental Assessment Program). I guess I am not certain of the charter of NAWDEX but it seems to me that what we are talking about is completely academic. I am quite sure that your funding isn't a function of the NAWDEX membership and, as such, I am sure our role is solely advisory. I guess whether you incorporate any recommendations we make or not, is solely a function of your interest in user input. I would think that interest should be represented to be about the same whether we vote--with 15 members present--or don't vote, and so I don't see why we should or how we could go through any lists of these recommendations and try to establish a consensus.

MR. LANG: Well, of course, the purpose of the discussion is to try to amplify what the interests of the group here are, and the intent is to make sure that the entire membership does have an opportunity to review what has happened at this meeting. And, as such, we may be missing some rather important interests or some important comments by rushing into something that, personally, I think we are not in a position to do. I feel that we have demonstrated to you our strong interest in trying to make NAWDEX responsive to user needs. That is the prime mission of the entire program. We are trying to incorporate some of your thoughts and ideas into the program and I think that will be reflected in future courses of action. As I mentioned before, what we can do in the future is not always within our capabilities. We have other impacts, other influences, that, in a sense, dictate just how much can be done. I just want to assure you that we are very much interested in improving NAWDEX in light of what we gather from this meeting, and we will attempt, as best we can, to incorporate these recommendations in our future plans.

There is one additional item on Dick's report that I would like to just quickly cover, and then we will go into the last panel report. Our time is rapidly running out, so, therefore, I don't like to shortchange Harold Lippmann's group. We can cut down on some of our final comments to give him some additional time.

The sixth point that Dick has is "Updating of the Water Data Sources Directory and solicitation of evaluations by listed agencies should be undertaken." I think that this is incorporated in the plans of NAWDEX. The Program Office does intend to carry through with a release of data from the Water Data Sources Directory back to the originating offices to give them the opportunity to review what is in there and to update the data periodically. Do you want to make any additional comment on that?

(No response.)

MR. LANG: We finally come to the report of Panel 1, which was headed by Harold Lippmann. This is the one on program administration, management and coordination, and the very first recommendation, of course, is what Harold describes as his most important point, which is that the staff of the NAWDEX Program Office should be increased. Do we need any further comment on that?

(No response.)

MR. LANG: I think the point has been made and it is in the record.

MR. LANG: The second item is: Action should be taken to increase NAWDEX membership. Do you have any specific items in the report with respect to that? I remember you talked about the slide presentation, and things like that.

MR. LIPPMANN: (National Weather Service, NOAA). Yes, we made specific recommendations for methods of increasing NAWDEX membership, and we discussed the slide and cassette type of presentation, and video tape. We believe that what is needed is a very professional job, one that would be very eye-catching, very appealing. We particularly felt that it was important that the flexibility of the Memorandum of Understanding be understood, the fact that it is not a rigid document and a rigid pattern which must be accepted verbatim as it is presented, but rather that it can be modified, and we understand that it must be modified from organization to organization. This should be highlighted in any presentation to any prospective NAWDEX member so as to make it understood that this is something that must be done. One way of doing it, of course, is by very graphic means, and this is why I was suggesting perhaps using cartoons or, in the case of video tape, an animated presentation.

We also would like to see the facilitation of regional and statewide NAWDEX organizations--NAWDEX type organizations--and we would like to see the Program Office facilitate some membership for these organizations in the National NAWDEX organization. We also would like to see present NAWDEX members do what they can to urge other organizations to become members of NAWDEX.

MR. LANG: Very good. Any comment?

MR. ROSS: (EPA, Region V). The NAWDEX Newsletter, I believe, has helped quite a bit, and the new NAWDEX brochure will help to present the advantages of NAWDEX.

MR. LANG: Let me just pose one question. In light of the last point you made, would you consider making these cassettes available, say, to members, and let them use these in making their points of contact, or making contact with the other agencies?

MR. LIPPMANN: Yes, any way that we can spread the word would be good. And if it is possible for one member organization to sponsor a meeting with another organization that might be interested in becoming a NAWDEX member, availability or use of the cassette or video tape for presentation would be most useful.

MR. TALCOTT: I would like to suggest that an alternative motion be given to the group here, and I would suggest that we vote on it. I would move that the NAWDEX Program Office provide members a formal mechanism for review and approval of program goals and objectives for 1979, and that the staff and funding of the Program Office be expanded to support the rapidly growing membership to serve its function. I propose that as an alternative to the motion that is presently out.

MR. LIPPMANN: Mr. Chairman, I will accept the amended resolution.

MR. LANG: Any discussion on that point?

MR. PEEL: (Department of Energy). I was just wondering if there is anything that this group can do or say that is going to determine how USGS staffs up this NAWDEX program anyway. I am wondering if maybe that first recommendation of the committee should have instead looked toward some types of alternatives for implementing the NAWDEX Program in the event that the staffing level stays the same. Maybe that is not the right recommendation.

MR. TALCOTT: Yes, we realize that we can't appropriate funds, but we want to formally express our encouragement that means be sought for expanding the office activity.

MR. LANG: We can indicate this as a consensus recommendation of the group. And I don't see why we need to take any formal action. It will be recorded in the record as such and it will carry that weight. Does that meet your needs?

MR. TALCOTT: So moved.

MR. WILSON: There is a second.

Mr. LANG: All in favor?

(Show of hands.)

MR. EDWARDS: I think you should show it was a unanimous vote.

MR. LANG: Item 3 states: An ad hoc advisory group should be formed from among NAWDEX members to meet more frequently than the full membership and give continuing guidance to the NAWDEX Program Manager. Do you want to amplify that a little bit?

MR. LIPPMANN: We are concerned, first of all, that there should be continuing guidance to the NAWDEX Program Manager, and we feel that this guidance should come from all areas of NAWDEX membership, and this is why we specified that there should be equal representation from each of the categories of NAWDEX membership, the Federal, State and local governments, and interstate, academic and private organizations. We feel that this is important so that the smaller, local-type organizations that are less frequently represented as NAWDEX members, will not feel that they are being suppressed or buried by the larger number of members, but will have a chance to express their viewpoints. So, we feel that the meetings which would be roughly quarterly would be appropriate. We also feel that the advantages of this type of organization are questionable enough so that we want this to be reviewed by the membership at the next annual meeting. Then we will know whether or not we want to continue.

MR. WILSON: (TNRIS). I want to support what Harold said. I think it is a good recommendation.

MR. LANG: All right. The last item is: The original NAWDEX concept should be continued. I don't see any cause for disagreement about that.

That concludes the session on the work group reports. I think we had an interesting discussion this morning, and I appreciate your participation and the comments that you made.

CONFERENCE SUMMARY

S. M. Lang, Chairman
Acting Assistant Chief Hydrologist for
Scientific Publications and Data Management
U.S. Geological Survey

I want to thank all those people who have taken part in this conference, especially those who served as chairmen of the four ad hoc panels. The enthusiasm you have shown reflects your interest in the NAWDEX program. Of course, we look forward to your participation in future meetings. I would also like to thank the people who presented papers. I thought they were all very interesting and informative, and with the long session that we had that day, I am sure half of you would have been asleep if they had not been interesting. I think our discussions that we had this morning essentially take the place of the summary statements I intended to make. I don't think there is any need, at this time, to go back and rehash some of the things we talked about. I think many of the points that were made are still fresh in our minds, especially those I consider to be more important ones. I do want to say thank you again, and we will look forward to seeing you at future meetings.

CLOSING REMARKS

M. D. Edwards, Program Manager
National Water Data Exchange

I would just like to say thanks to all of you for being here. I think it has been a very good first conference. It has been most informative to me. I have obtained a lot of input to the program here this week that I feel sure I wouldn't have gotten otherwise without the personal contact that we have had over the last 2 or 3 days. I want to express my own personal appreciation to the panel chairmen for the very fine job that they did yesterday. I know you worked late last night and this morning. It is a very important contribution to the program and I greatly appreciate your efforts. I would also like to express my appreciation to all of the speakers. A lot of work went into the papers that were presented on the first day of the conference. I think perhaps it is one of the most impressive presentations of water data systems that I have seen and listened to.

I would like to thank Sol Lang for serving as chairman of the conference. I would like to thank my staff for being very patient and working very hard on the conference. I assure you that the Program Office will pay attention to what has been said here the past 3 days. We are paying close attention to the personal input we have had in individual conversations. Not only is a large portion of my staff here, but also our major contractor is represented. He has spent a lot of time discussing systems applications with some of you. I will do what I can to get the information from this conference to you as quickly as possible, and I most certainly assure you that whatever is possible for me to implement personally out of this conference will be done as quickly as possible. I assure you that for those items that I cannot implement, I will tell you so as quickly as possible so that we can start looking for alternatives. Once again, thank you for coming. It has been most gratifying for me and the entire NAWDEX staff to have the attendance and representation that we have had here this week. Thank you for the support that you have displayed, not only by your presence, but in the recommendations that have come out of the panels. It has been very supportive to the program. Beyond that, all I can do is say thank you, have a good, safe trip home, and we will see you next year.

APPENDIX A

AGENDA

National Water Data Exchange (NAWDEX)
First Membership Conference
Denver, Colorado
May 9-11, 1978

<u>May 8, 1978</u>

7:00 - 9:00 p.m.	Registration - Hotel Lobby, Denver Marina Hotel

<u>May 9, 1978</u>

8:00 - 9:00	Registration - Hotel Lobby Exhibits - Big Horn Room N. 1 - 1st Floor General Session - Big Horn Rooms 2-3, 1st Floor
9:00 - 9:10	Welcome: S. M. Lang, USGS, Conference Chairman
9:10 - 9:30	Keynote Address: J. S. Cragwall, Jr., Chief Hydrologist, USGS
9:30 - 9:50	Water Data Coordination and the Support Role of NAWDEX: R. H. Langford, Office of Water Data Coordination, USGS
9:50 - 10:05	Conference Objectives: M. D. Edwards, NAWDEX Program Office, USGS
10:05 - 10:20	Coffee Break (Big Horn Room No. 1)
10:20 - 10:35	NAWDEX Program Status Report: M. D. Edwards, NAWDEX Program Office, USGS
10:35 - 10:55	The Colorado Water Data Bank - Implementation and Utilization: Mr. W. I. Knudsen, Jr., Colorado Division of Water Resources, Colorado
10:55 - 11:15	The Texas Natural Resources Information System: John Wilson, TNRIS, Texas
11:15 - 11:30	Open Discussion
11:30 - 12:45	Lunch
12:45 - 1:05	Design and Development of the Iowa Water Resources Data System: R. L. Talcott, Iowa Geological Survey, Iowa
1:05 - 1:25	Data Needs for Stormwater Modeling, Treatment and Control: Dr. Miguel A. Medina, Jr., School of Engineering, Duke University
1:25 - 1:45	The National Water Data Storage and Retrieval System (WATSTORE): C. R. Showen, Water Resources Division, USGS
1:45 - 2:05	The National Water-Use Data System and the Support Role of NAWDEX: F. H. Ruggles, Jr., Water Resources Division, USGS
2:05 - 2:25	Nebraska Natural Resources Information System: Dr. M. K. Bansal, Nebraska Natural Resources Commission

2:25 - 2:45	SNOTEL: Bernard Shafer, Soil Conservation Service
2:45 - 3:00	Coffee Break (Big Horn Room No. 1)
3:00 - 3:20	Water Data Activities of the National Oceanic and Atmospheric Administration: Harold Lippmann, Office of Hydrology, National Weather Service, NOAA
3:20 - 3:40	The Environmental Data Service - An Overview: Robert Freeman, Environmental Data and Information Service, NOAA
3:40 - 4:00	The Water Resources Scientific Information Center (WRSIC): Ray Jensen, WRSIC, Office of Water Research and Technology
4:00 - 4:20	Water Data and the North Dakota REAP system: John R. Reid and Richard V. Giddings, North Dakota Regional Environmental Assessment Program
4:20 - 4:40	Recommended Methods for Water Data Acquisition - A Guide to Developing NAWDEX Standards: A. I. Johnson, Office of Water Data Coordination, USGS
4:40 - 5:00	Open Discussion
6:00 - 7:30	Social Gathering (Summit Rooms, 5th Floor)
<u>May 10, 1978</u>	General Session (Big Horn Rooms 2-3, 1st Floor)
8:30 - 8:45	NAWDEX Program Objectives for Fiscal Year 1979: M. D. Edwards NAWDEX Program Office, USGS
8:45 - 9:15	Open Discussion
9:15 - 9:30	Charge to Ad Hoc Panels: M. D. Edwards, NAWDEX Program Office, USGS
9:30 - 10:00	Coffee Break
10:00 - 5:00	Simultaneous Ad Hoc Panel Sessions: (Lunch: 11:30 - 12:45; Coffee Break: 2:45 - 3:00, Big Horn Room No. 1, 1st Floor)

1. Program Administration, Management and Coordination: Chairman: Mr. Harold Lippmann, Hydrologic Services Division, Office of Hydrology, National Weather Service, NOAA (Timberline Room No. 1, 5th Floor)

2. Recommended Standards for the Handling and Exchange of Water Data: Chairman: Mr. Walter I. Knudsen, Jr., Colorado Department of Natural Resources, Division of Water Resources (Timberline Room No. 2, 5th Floor)

3. Water Data Indexing and Technical Systems Development: Chairman: Mr. Richard L. Talcott, Manager, Iowa Water Resources Data System, Iowa Geological Survey (Timberline Room No. 3, 5th Floor)

4. Request, Response, and Service Activities: Chairman: Mr. John Wilson, Manager, Systems Central, Texas Natural Resources Information System
(Timberline Room No. 4, 5th Floor)

<u>May 11, 1978</u>	General Session (Big Horn Room 2-3, 1st Floor)
8:30 - 10:00	Reports of Ad Hoc Panel Chairmen
10:00 - 10:20	Coffee Break (Big Horn Room No. 1)
10:20 - 11:30	Member comments and discussion
11:30 - 12:00	Conference summary and closing remarks: S. M. Lang, Conference Chairman and M. D. Edwards, NAWDEX Program Manager
12:00	Adjournment

Exhibitors (Big Horn Room No. 1, 1st Floor)

Environmental Data Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Nebraska Natural Resources Commission, Nebraska (NNRIS)

Soil Conservation Service, U.S. Department of Agriculture (SNOTEL)

Texas Natural Resources Information System, Texas (TNRIS)

U.S. Council on Environmental Quality (UPGRADE system)

U.S. Environmental Protection Agency (STORET)

Geological Survey, Water Resources Division, U.S. Department of the Interior (NAWDEX and WATSTORE)

Water Resources Document Reference Centre, Department of Fisheries and the Environment, Canada (WATDOC)

Water Resources Scientific Information Center, Office of Water Research and Technology, U.S. Department of the Interior (WRSIC)

APPENDIX B

FIRST MEMBERSHIP MEETING
OF THE
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APPENDIX C

ACRONYMS AND ABBREVIATIONS USED DURING THE NAWDEX CONFERENCE

ADP - Automatic Data Processing
CEDDA - Center for Experiment Design and Data Analysis
CEQ - Council on Environmental Quality
CSU - Colorado State University
CWDB - Colorado Water Data Bank
DBMS - Data Base Management System
DOE - Department of Energy
EDS - Environmental Data Service
ENDEX - Environmental Data Index
EPA - Environmental Protection Agency
ESIC - Environmental Science Information Center
GIPSY - Generalized Information Processing System
IWARDS - Iowa Water Resources Data System
MWDI - Master Water Data Index
NAWDEX - National Water Data Exchange
NCC - National Climatic Center
NOAA - National Oceanic and Atmospheric Administration
NODC - National Oceanographic Data Center
NTIS - National Technical Information Service
NWS - National Weather Service
NWUDS - National Water Use Data System
OASIS - Oceanic and Atmospheric Scientific Information System
OWDC - Office of Water Data Coordination
OWRT - Office of Water Research and Technology
REAP - Regional Environmental Assessment Program
RECON - Remote Console
SCS - Soil Conservation Service
SNOTEL - Snow Telemetry System
STORET - Storage and Retrieval System
SWRA - Selected Water Resources Abstracts
TNRIS - Texas Natural Resources Information System
UPGRADE - User Prompted Graphics Data Evaluation System
USEPA - U.S. Environmental Protection Agency
USGS - U.S. Geological Survey
WATDOC - Water Document Reference Centre
WATSTORE - National Water Data Storage and Retrieval System
WDSD - Water Data Sources Directory
WRD - Water Resources Division
WRSIC - Water Resources Scientific Information Center

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