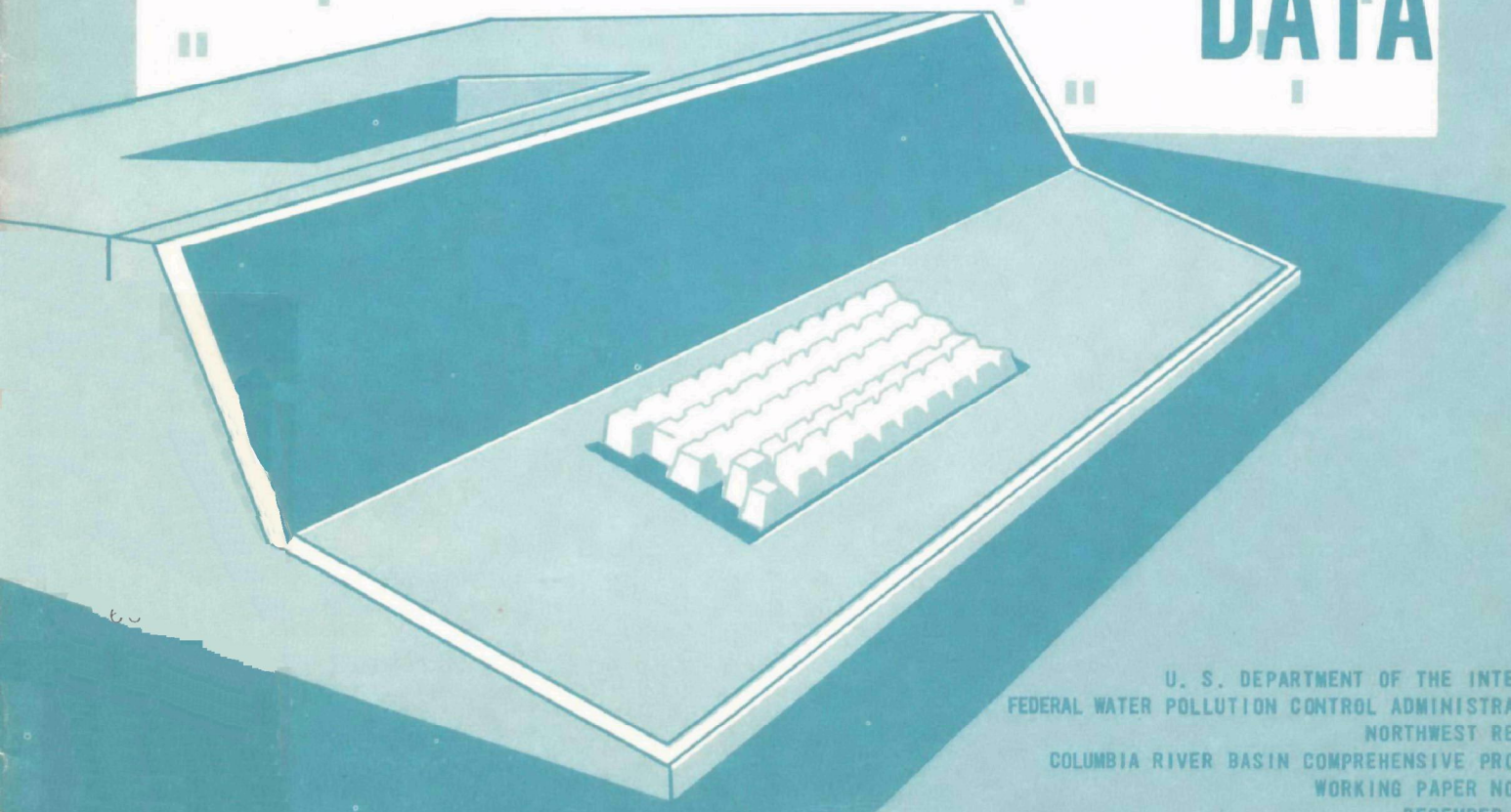
A SYSTEM FOR STORAGE AND RETRIEVAL OF WATER USE INVENTORY DATA



U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
NORTHWEST REGION
COLUMBIA RIVER BASIN COMPREHENSIVE PROJECT
WORKING PAPER NO. 59
DECEMBER 1966

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A SYSTEM FOR STORAGE AND RETRIEVAL OF WATER USE INVENTORY DATA

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INTRODUCTION

Water resource planning and development must inescapably be informed and directed by consideration of water use patterns. Existing configurations of water use shape the conditions that determine resource utilization possibilities; while the potentialities of use must be reflected in and governed by resource development.

In particular, water quality levels exercise a limiting effect on water use capabilities; in turn, the nature and intensity of water use directly affect water quality. Water quality planning, then, must include a realistic consideration of water utilization if it is to result in optimal water quality measures and expenditures. Certainly there can be no realistic water quality objectives or standards without a reference to water uses.

Much information concerning water use has been collected in connection with comprehensive water pollution control projects now underway in many parts of the country. Numerous other local, State and Federal agencies also have data of this type. Unfortunately, however, these data are not necessarily in a readily usable or consistent form.

Because of the definite and immediate need for a detailed inventory of present and potential water uses, in addition to the lack of an operating system for compiling such information, personnel of the FWPCA Columbia River Basin Project have developed a simple, but workable, system for the storage and retrieval of water use inventory data. It is hoped that this system will serve as a tool for both State and FWPCA personnel in the development of water quality standards in the Northwest Region, as well as serve the needs of those involved in long-range planning.

BACKGROUND

Development of a comprehensive data storage and retrieval system for use by water pollution control personnel was initiated in 1961. The first two elements of this system, known as STORET Subsystems I and II, have since been placed in operation. These systems provide a means for efficient storage and retrieval of the huge quantities of water quality data generated by activities of the many groups interested in defining and measuring the water pollution problem. Also operational are a series of auxiliary computer programs designed to aid in the computation and summarization procedures required to discern meaning from the many individual facts available.

With the transfer of water pollution control functions to the Department of the Interior, the use of the USPHS Honeywell Model 400 computer will be phased out. In its place will be an IBM 360 Model 65 computer, a much larger, faster and more flexible machine. However, the complex job of reprogramming existing systems for this new machine and its associated terminal facilities will undoubtedly necessitate some delays in the development of additional systems to provide storage and retrieval of such information as water and waste treatment facility inventories (STORET III and IV), biological data (STORET V and VI), economic and demographic data and, possibly, water use inventory data.

The Northwest Regional Office has easy access to the computer center at Oregon State University in Corvallis, Oregon, and has close working relationships with personnel at the computer center. Therefore the system described in this paper was programmed for the Control Data Corporation Model 3300 computer. With some revision and additional programming, the system could be used by others throughout the nation. Certain technical programming difficulties associated with conversion of system programs for use on other computers may be anticipated; however, these difficulties are not expected to be insurmountable.

SYSTEM DESCRIPTION

Basic elements of the system for storage and retrieval of water use inventory data consist of: (1) procedures to identify and store data concerning the location of various stream reaches under consideration; (2) procedures to record and store water use data including such parameters as use category, intensity of use, and time of use; (3) methods of updating and revising existing data as better and more reliable information become available; and (4) methods of retrieving the data in any one of several ways to best fit the needs of users.

Reach Location Code - The reach location code is based on and compatible with the STORET Subsystem I location code concept, which utilizes a stream mileage and indexing method of locating any point on any stream in the United States. (Those readers unfamiliar with STORET Subsystem I are referred to the publication entitled, "The Storage and Retrieval of Data for Water Quality Control" by Richard S. Green.) Thus, any reach of any stream may be described by defining the downstream end point of the reach with the proper STORET Subsystem I location code and providing an additional number which represents the reach length to the upstream end point of the reach.

The boundaries of stream reaches should be defined to allow for the inclusion of enough data to adequately describe the water uses of the stream system under consideration. System users may find any or all of the following reach boundary criteria of value in defining stream reaches:

1. Confluence of major tributary streams
2. State lines
3. Existing dams
4. Probable future dams
5. Gaging stations
6. Prominent physical features

The reach location code is not, at present, completely adapted to reaches in estuarial waters where interlocking channels or large open water bodies cannot easily be fitted into the Subsystem I location code scheme. If, at a later date, it becomes desirable to define such reaches, it is conceivable that the system could be adapted to the coordinate location coding scheme utilized in STORET subsystem II, described in the publication entitled, "Storage and Retrieval of Data for Open Water and Land Areas" by Donald P. Dubois.

Use Parameter Code - Water use inventory data varies significantly from other forms of information - such as water quality data - in that many times the information may be based on opinion and professional judgment rather than on measurable quantitative fact. Indeed, the problem of quantifying various water use data, particularly in such use categories as "environmental aesthetics", will require major refinements of descriptive techniques. For this reason, it was decided to develop the system in rather general terms for the present, and to leave the system somewhat "open ended" so that quantitative data, possibly including economic evaluation, might be incorporated at a later date. Separate categories for present uses as well as potential uses have been provided for, however.

The various water use parameters and associated codes for which the system was originally programmed are listed and explained in Table 1. The use parameter coding is flexible and will accomodate the addition of other use parameters if it is later deemed desirable. It should also be noted that in some cases, for example the water supply category, uses are broken down into as many as three levels of detail. Thus, it is possible to describe separately a use such as industrial cooling water, or process water, if such detail is available, or to describe the use merely as industrial water supply if detailed information is lacking.

In order to describe the relative magnitude of water use, a simple 'light-moderate-heavy' use intensity triad was incorporated into the system. It is recognized that a general evaluation of this type has many drwwbacks; however, it was felt that an attempt to provide a more detailed quantification concept would create more problems than it would solve at this time.

The intensity of use category should be considered as a magnitude indicator for a water use within a specific reach of a stream, not merely as an indicator of the magnitude of the specific water use. For example, an irrigation diversion of 100 cfs from a stream reach carrying 10,000 cfs might be considered as a 'light' use, while the same diversion from a stream reach carrying 150 cfs might be considered as a 'heavy' use.

Finally, because of the importance of seasonal factors associated with many water uses, a summer-fall-winter-spring time of use category was provided for in the system. While it might be possible to go into further detail concerning time of use, such as listing the months in which a use occurs, it is doubtful that such detail would add much value to the system.

TABLE 1

WATER USE PARAMETER CODES

000	Fisheries
010	Salmonid (salmon and trout species)
011	Migration
012	Rearing
013	Spawning
020	Warm-water game fish
021	Rearing
022	Spawning
030	Shellfish
040	Other fish (e.g., shad, sturgeon)
100	Wildlife
110	Waterfowl
120	Game
130	Other wildlife
200	Recreation
210	Water-contact
220	Bankside
230	Boating
300	Water Supply
310	Domestic
320	Industrial
321	Boiler feed
322	Cooling water
323	Transportation water
324	Process water incorporated in product
325	Other process water
330	Stock watering
400	Environmental Aesthetics
410	Recreational
411	Parks
412	Wild areas (not restricted to officially designated wild areas)
420	Non-recreational
421	Homesites (including summer homes)
422	Viewpoints
423	Civic features (water part of environmental planning)
500	Irrigation
600	Waste Assimilation (existence of significant waste loads)
700	Navigation (commercial navigation and/or locks)
800	Hydropower (≥5,000 kw generating capacity)

DATA STORAGE PROCEDURES

The techniques of data storage for this system involve the identification of data relating to: (1) the location and description of stream reaches in which water use data are to be described; and (2) the water use parameters, use intensity, and time of use associated with each stream reach described. These data are coded into punched cards, which are then used to store the data on magnetic tape so that the water use inventory may either be revised or retrieved by system users.

Cards 01, 02 and 03 are used to store location and identifying information for a particular stream reach. The card series 20 through 29 are used to store present water use data and the card series 30–39 are used to store potential water use data. Detailed instructions for coding each of these cards follow.

Card 01--Storet Location Code: Figure 1

1. Serial Reach Code (Columns 1-6)--The purpose of this field is to record a unique number which serves as a descriptive label for a particular stream reach. This six-digit reach code appears on all other cards associated with that particular stream reach and is used in the revision or updating and retrieval of data. The first two digits of this number represent a State code which is compatible with State codes developed in STORET Subsystem I as follows:

Idaho	15	Utah	49
Montana	29	Washington	54
Nevada	31	Wyoming	57
Oregon	40		

The following four digits represent a number assigned serially to define a unique stream reach.

2. STORET Location Code (Columns 7-76)--This field is used to define the downstream end point of a stream reach. The code is based on the location concept developed for STORET Subsystem I and may be broken down into the following sub-fields:

Col. 7-8 - Terminal Major Basin
9-10 - Terminal Minor Basin
11-13 - Terminal Stream Number
14-19 - Level I Mileage
20-25 - Level II Index
26-31 - Level II Mileage
32-36 - Level III Index
37-41 - Level III Mileage
42-45 - Level IV Index
46-50 - Level IV Mileage
51-54 - Level V Index
55-59 - Level V Mileage
60-63 - Level VI Index
64-68 - Level VI Mileage
69-72 - Level VII Index
73-76 - Level VII Mileage

3. Unused Field (Columns 77-78).

4. Card Number (Columns 79-80)--Always punch "01" to indicate card 01.

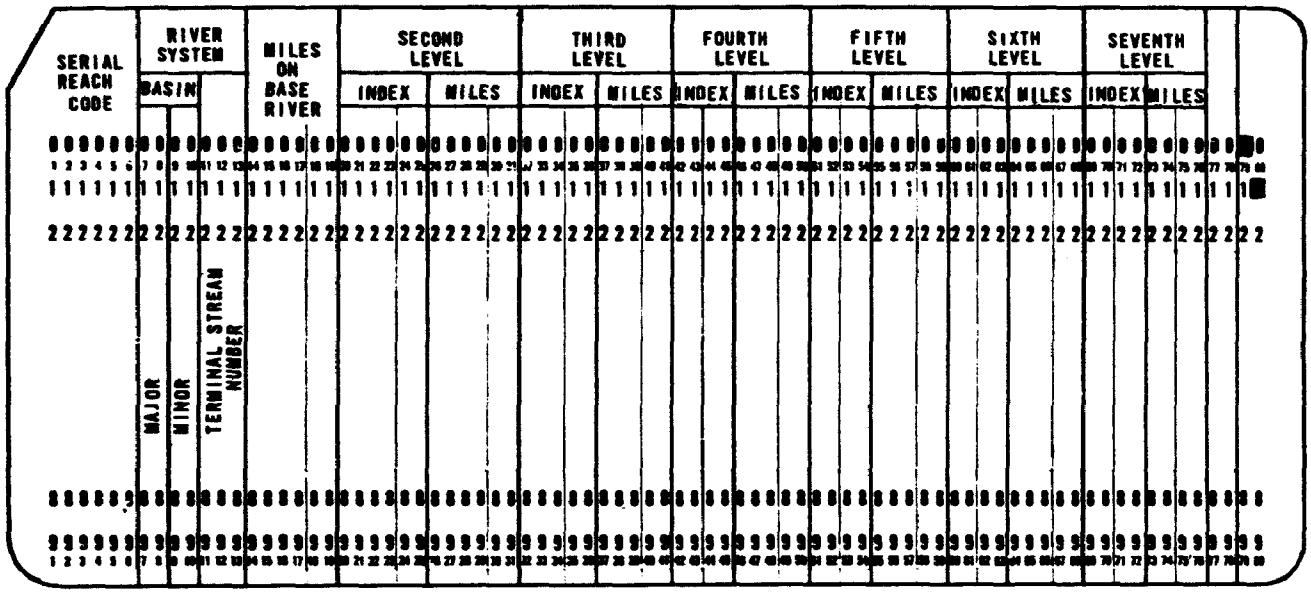

Figure 1

Card 02--Reach Description: Figure 2

1. Serial Reach Code (Columns 1-6)--Previously described under section entitled "Card 01--STORET Location Code".

2. Reach Description (Columns 7-78)--This field is used to provide a literal description of the reach for those users unfamiliar with the STORET Subsystem I location code scheme. For example, a reach might be described as "SNAKE RIVER FROM MOUTH OF BURNT RIVER TO MOUTH OF WEISER RIVER".

3. Card Number (Columns 79-80)--Always punch "02" to indicate card 02.

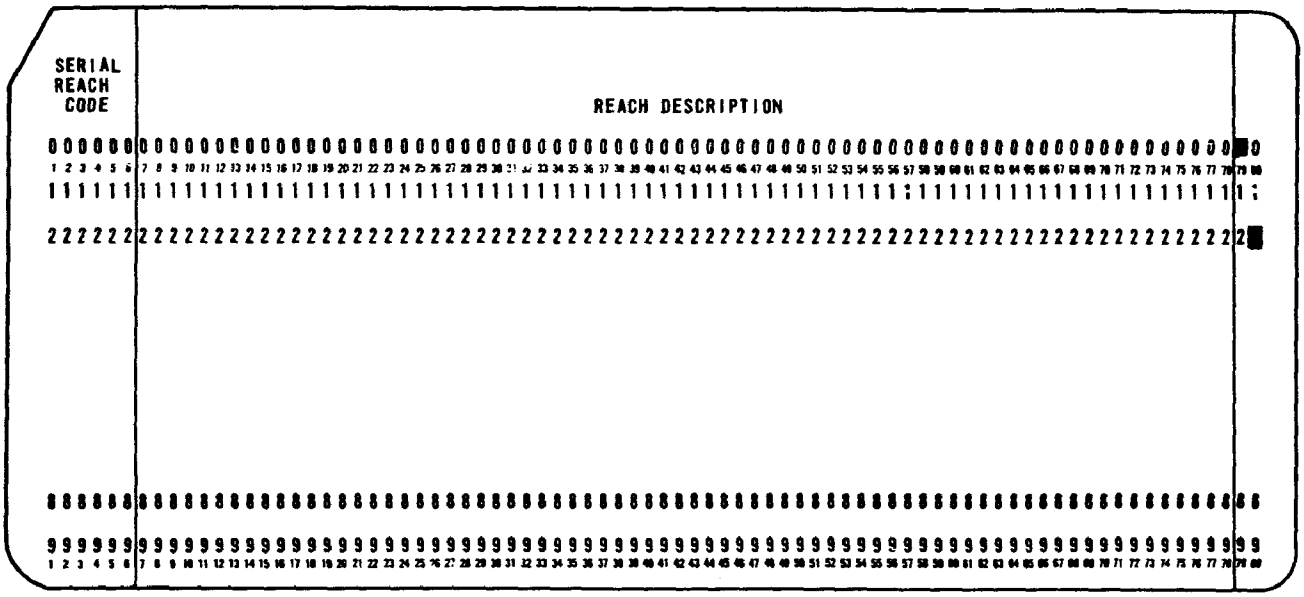

Figure 2

Card 03--Reach Length, Description and Revision Date: Figure 3

1. Serial Reach Code (Columns 1-6)--Previously described under section entitled "Card 01--STORET Location Code".

2. Secondary State Code (Columns 7-8)--If the stream reach forms the boundary between two states, the state code *not* used in the first two digits of the serial reach code should be placed in this field. If the stream reach lies within a given state, this field should be coded as "00".

3. Reach Length (Columns 9-12)--The reach length to the nearest one-tenth mile should be entered in this field.

4. Revision Date (Columns 13-18)--If any present or potential water use data are revised or updated in a particular reach, this field should also be revised to indicate the date of revision. The date should be entered in this six digit field in the month-day-year form.

5. Unused Field (Columns 19-78).

6. Card Number (Columns 79-80)--Always punch "03" to indicate card 03.

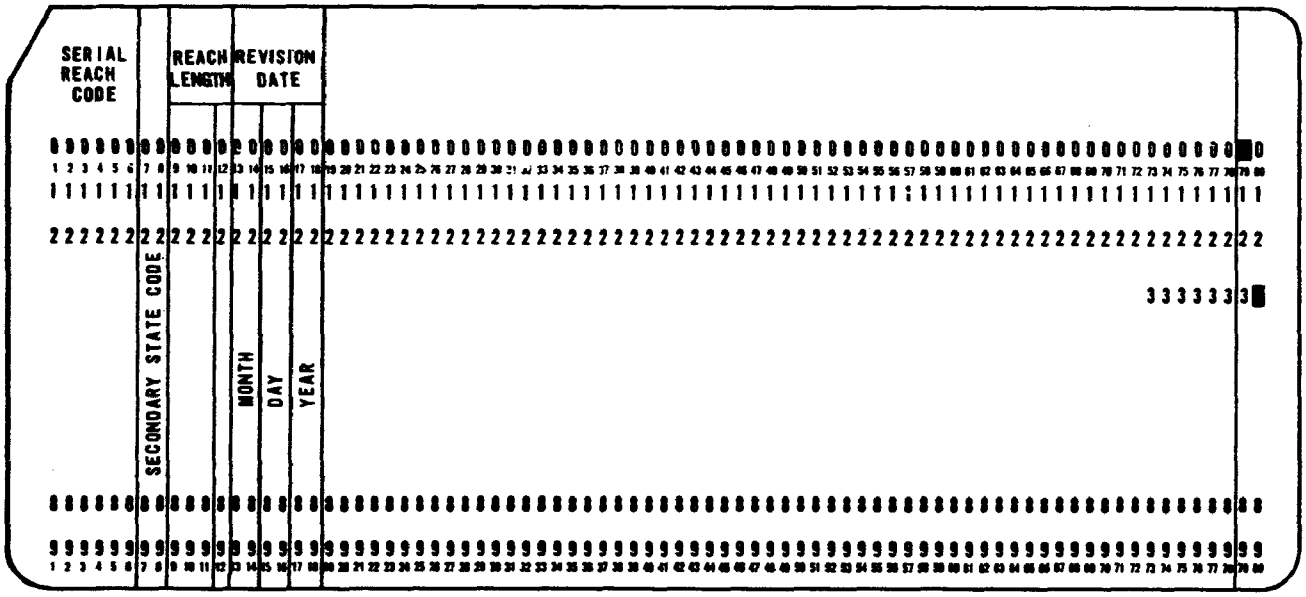

Figure 3

Cards 20–29--Present Water Use Data: Figure 4

1. Serial Reach Code (Columns 1-6)--Previously described under section entitled "Card 01 - STORET Location Code".

2. Present Water Use Data (Columns 7-78)--Each water use parameter, with the associated use, intensity and time of use is coded into an eight-digit field as follows:

a. Water Use Parameter Code (Columns 7-9, 15-17, etc.)--The three-digit code of the parameter in question is entered. (See Table 1 for a list of water use parameter codes.)

b. Intensity of Use Code (Columns 10, 18, etc.)--A one-digit use intensity code for the use in question is entered. This code is in the following form:

Heavy	1
Moderate	2
Light	3

c. Time of Use Code (Columns 11-14, 19-22, etc.)--The four-digit time of use code is entered in the field for the use in question. If a use occurs during the summer season, a "1" is coded into the first column of this field. If a use does not occur during the summer season, a "0" is coded into the first column of this field. The second through fourth columns of the field represent the fall, winter, and spring seasons, respectively. For example, a use occurring during the fall and spring seasons would be coded "0101" in this field, while a year-round use would be coded as "1111".

3. Card Number (Columns 79-80)--Code serially beginning with "20".

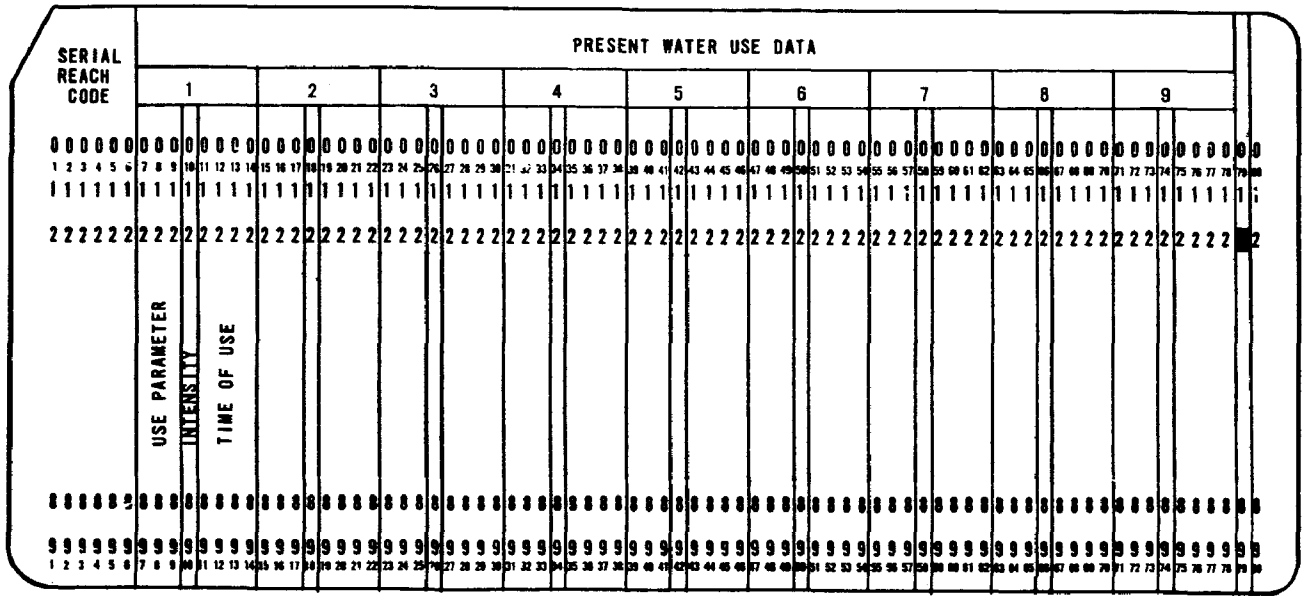

Figure 4

Cards 30–39--Potential Water Use Data: Figure 5

The potential water use data are coded in precisely the same manner as the present water use data with the exception that the card number (Columns 79–80) is coded serially beginning with "30".

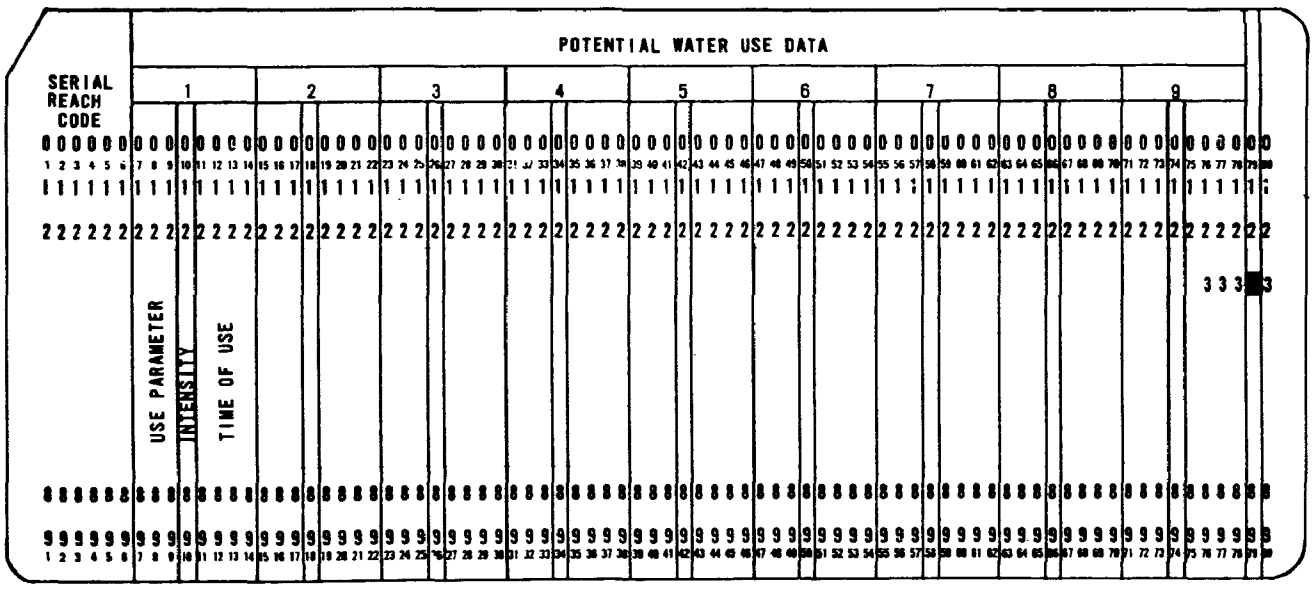

Figure 5

An actual deck of input cards containing all necessary data for the description of present and potential water uses in an example reach is shown in Figure 6. These particular data were stored on magnetic tape and then retrieved to provide the example retrieval format, which is later discussed and shown in Figure 7.

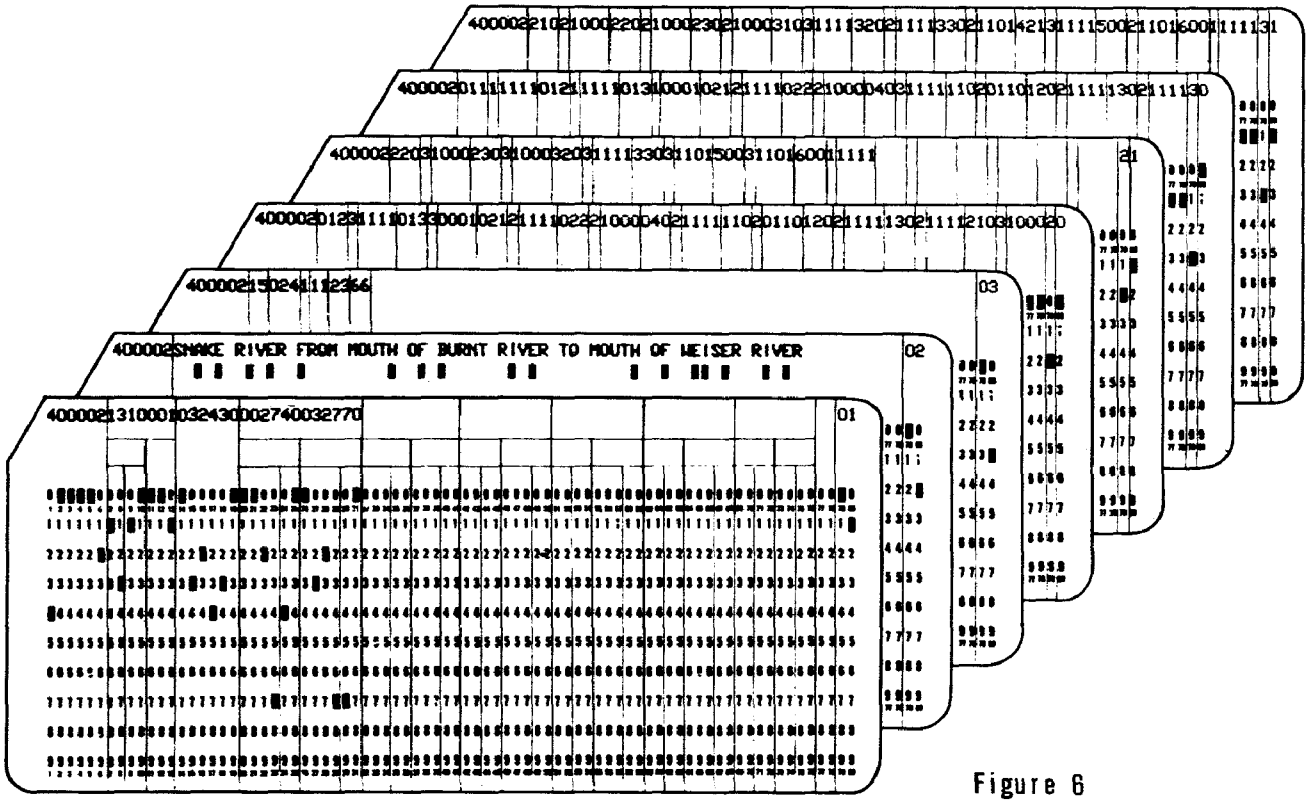

Figure 6

DELETING AND CHANGING DATA

In any procedure for storing and retrieving data, it is important to be able to delete and change data already stored if errors are discovered or if outdated descriptive information must be replaced. No attempt has been made in the development of this system to provide any more than the simplest form (in terms of system programming) of deleting and changing the water use data.

The method of deleting and changing data in storage has been tied to the original input data. If at any time a revision of any data on a given card is desired, a complete new card containing the revisions must be submitted for storage. Thus, if an error is discovered in Column 17 of Card 20, for example, the procedure for correcting this error is to submit a new, complete and correct (in Column 17) Card 20 for storage. The computer operator will then insert the card for storage, which will automatically erase the original data and store the new correct data in its place on the magnetic tape. Likewise, if one desires to delete data for a particular water use in a given reach, he should prepare and submit for storage a card which contains all of the original data *except* that data which is to be deleted.

If and when any data are deleted or changed for a particular reach, a new card 03 should also be submitted to reflect the latest revision date. It should be noted here that the revision date applies only to a particular stream reach--not to an entire stream system.

To facilitate the use of this rather limited method of deleting and changing

data, an updated listing of the input data submitted for storage should be kept on file in the office of those responsible for data storage. An updated file of the key-punched input cards might be used in place of the listing mentioned above.

DATA RETRIEVAL

After the information contained on the location, description and use data cards has been stored on magnetic tape, a retrieval routine is used to obtain printouts in the output format indicated in Figure 7. Again, no attempt has been made in the development of this system to provide any more than the simplest forms (in terms of system programming) of water use data retrieval.

All of the data in storage for a given stream reach is obtained when a data retrieval is run for that reach. The system user may request retrieval of data from any reach or any series of reaches and obtain the output in any reach sequence. To do this, the user must submit to the computer operator a deck of retrieval cards consisting of a separate retrieval card for each reach from which output data are desired. The data retrieved will be printed out in the same sequence in which the retrieval cards are submitted; thus, the user may obtain his output data in any sequence desired. The retrieval cards used in this manner have the applicable serial reach code entered in Columns 1-6, with Columns 7-80 unused.

In addition, it is possible to retrieve all of the water use data within a given state in numeric serial reach code sequence by submitting to the computer operator a single retrieval card carrying the applicable state code in Columns 1-2, with Columns 3-80 unused.

WATER USE INVENTORY

SERIAL REACH CODE IS 400002 RETRIEVAL DATE 11/27/66

STORET LOCATION CODE PAGE 1
1310300103243000274003277 0

* REACH DESCRIPTION *

*** SNAKE RIVER FROM MOUTH OF BURNT RIVER TO MOUTH OF WEISER RIVER

REACH LENGTH =024.1 MILES OREGON-IDAHO BORDER REVISION DATE 11/23/66

* PRESENT WATER USES *

USES SERVED	INTENSITY OF USE	TIME OF USE
FISHERIES		
SALMONID		
REARING	LIGHT	S F W S
SPAWNING	LIGHT	S
WARM-WATER GAME FISH		
REARING	MODERATE	S F W S
SPAWNING	MODERATE	S
OTHER FISH	MODERATE	S F W S
WILDLIFE		
WATERFOWL	MODERATE	F W
GAME	MODERATE	S F W S
OTHER WILDLIFE	MODERATE	S F W S
RECREATION		
WATER CONTACT	LIGHT	S
BANKSIDE	LIGHT	S
BOATING	LIGHT	S
WATER SUPPLY		
INDUSTRIAL	LIGHT	S F W S
STOCK WATERING	LIGHT	S F S
IRRIGATION	LIGHT	S F S
WASTE ASSIMILATION	HEAVY	S F W S

Figure 7

WATER USE INVENTORY

SERIAL REACH CODE IS 400002 RETRIEVAL DATE 11/27/66

STORET LOCATION CODE
1910010324300027400327?0 PAGE 2

* REACH DESCRIPTION *

*** SNAKE RIVER FROM MOUTH OF BURNT RIVER TO MOUTH OF WEISER RIVER

* POTENTIAL WATER USES *

USES TO BE SERVED	INTENSITY OF USE	TIME OF USE
FISHERIES		
SALMONID		
MIGRATION	HEAVY	S F W S
REARING	HEAVY	S F W S
SPAWNING	HEAVY	S
WARM-WATER GAME FISH		
REARING	MODERATE	S F W S
SPAWNING	MODERATE	S
OTHER FISH	LIGHT	S F W S
WILDLIFE		
WATERFOWL	MODERATE	F W
GAME	MODERATE	S F W S
OTHER WILDLIFE	MODERATE	S F W S
RECREATION		
WATER CONTACT	MODERATE	S
BANKSIDE	MODERATE	S
BOATING	MODERATE	S
WATER SUPPLY		
DOMESTIC	LIGHT	S F W S
INDUSTRIAL	MODERATE	S F W S
STOCK WATERING	MODERATE	S F S
ENVIRONMENTAL AESTHETICS		
NON-RECREATIONAL		
HOME SITES	LIGHT	S F W S
IRRIGATION	MODERATE	S F S
WASTE ASSIMILATION	HEAVY	S F W S

POSSIBLE FUTURE SYSTEM DEVELOPMENT AND USE

This system for storage and retrieval of water use inventory data was developed to meet the immediate needs of the FWPCA Northwest Regional Office. System programming and development efforts were purposely held to a minimum, with the primary goal being that of producing a simple, workable system which could be available for use within a rather short span of time. At present, display of output data from the system is limited to the format previously shown in Figure 7. It is possible, however, to convert these output data into a meaningful graphical form by developing a plot of various water uses versus river miles for the stream under consideration.

Consideration of possible future development and use of the system has led to some interesting ideas, however. It might be worthwhile to document some of these thoughts here.

Future development of the system might logically be directed toward more complete compatibility with the existing STORET system. Certainly the methods of data storage, revision and retrieval could be improved with additional programming effort. Further expansion of the system might lead to the incorporation of the much needed, previously mentioned, quantification of water use data. As methods for economic evaluation of the worth of water in its various use forms become more sophisticated, it would seem logical that data of this type might also be included as part of the system.

In many aspects of water pollution control, the interval between the time when raw facts are at hand and decisions based on these facts must be made has become very short. In such cases, it is vital that there be a way to assemble very quickly all facts bearing on the problem, to perform any mathematical manipulations needed on these data, and present the analyzed findings to the decision-making body. To meet this need, a fully integrated approach

to the entire field of data collection, processing, analysis, reporting, and use is presently under development at the headquarters level.

Certainly, the water use inventory has a place in such an integrated scheme. For example, the water use inventory could be tied to an inventory consisting of water quality criteria required to support various water uses, with the result being a determination of the limiting, or even the most economically desirable set of water quality parameters for a given stream reach, during a given time period. Present water quality data for that particular stream reach might then be submitted to the system in order to compare the present quality with the necessary or desirable quality condition determined previously. If the present quality condition were below that determined to be necessary or desirable, the system might conceivably be programmed to determine why such a condition exists--and, possibly, what to do to best rectify such a situation.