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ENVIRONMENTAL SCIENCES DIVISION

DATA BASE MANAGEMENT FOR THE REMEDIAL ACTION PROGRAM AT OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

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The Oak Ridge National Laboratory's (ORNL's) Remedial Action Program was established to provide appropriate corrective measures at over 140 sites that were contaminated with radioactive and/or hazardous chemical wastes. To achieve this goal, numerous and varied studies are being conducted which will result in the collection of an unprecedented amount of data for the ORNL site. To manage such data effectively and efficiently, a computerized data base is being developed. The data base provides a unified repository for all data generated within the Remedial Action Program, to allow for necessary storage, manipulation, analyses, assessment, display, and report generation.

Data base management for the Remedial Action Program is documented in this report by (1) defining the organization of the data management staff and the services provided; (2) describing the design of the data base, including its management system, organization, and applications; (3) providing examples of the current and anticipated tasks; and (4) discussing quality assurance measures implemented to control the accuracy of the data entries and the security of the data.

1. INTRODUCTION

The Oak Ridge Reservation was established in 1941 as part of the "Manhattan Project" to produce the atomic bomb. A portion of the reservation, now designated as the Oak Ridge National Laboratory (ORNL) site, was selected as the location for the development of a prototype reactor and reprocessing facility for the production of plutonium. Consequently, from its beginning, ORNL has generated large quantities of fission-product, uranium, and transuranic waste solutions, as well as solid radioactive wastes.

Although it was originally anticipated that the mission of ORNL would be short-lived (1 to 2 years), the facilities were soon expanded to provide for peacetime applications of nuclear power and other energy technologies. Today, ORNL continues to generate not only large quantities of radioactively contaminated waste but also a wide variety of nonradioactive hazardous wastes, all of which are regulated by numerous environmental laws and regulations.

In FY 1985, ORNL established the Environmental Restoration and Facilities Upgrade (ERFU) Program to address the immediate and long-range needs for complying with all applicable federal and state environmental regulations. The Remedial Action (RA) Program is one component of ORNL's ERFU Program. One of the primary purposes of the RA Program is to provide corrective measures and facility decommissioning necessary to place ORNL in compliance with applicable environmental and health regulations for radioactive and hazardous chemical wastes. To achieve this goal, numerous and varied studies are being conducted on the reservation; these studies will result in the collection of voluminous data on an unprecedented scale for the ORNL site. To manage such data effectively and efficiently, a computerized data base is being developed. The data base is being constructed to provide a unified repository for all RA data to allow for necessary storage, manipulation, analyses, assessment, display, and report generation. The relationship of the DBM system to other components of the RA Program is illustrated in Fig. 1.

1.1 PURPOSE AND SCOPE

The purpose of this report is to describe the Data Base Management (DBM) system being developed for the RA Program. This is accomplished by (1) defining the organization of the DBM team as well as the general requirements of each staff position and the services provided; (2) describing the design of the data base including its management system, organization, and potential applications; (3) providing examples of the current and anticipated DBM tasks; and (4) discussing quality assurance measures implemented to control the accuracy of the data entries and the security of the data. In addition to being an essential document for the RA Program, this report serves to illustrate an approach used to manage large and highly varied data sets. The report is not intended to be a user's guide for the data base; such initial guidance will be developed after the system has evolved into a more comprehensive repository of information.

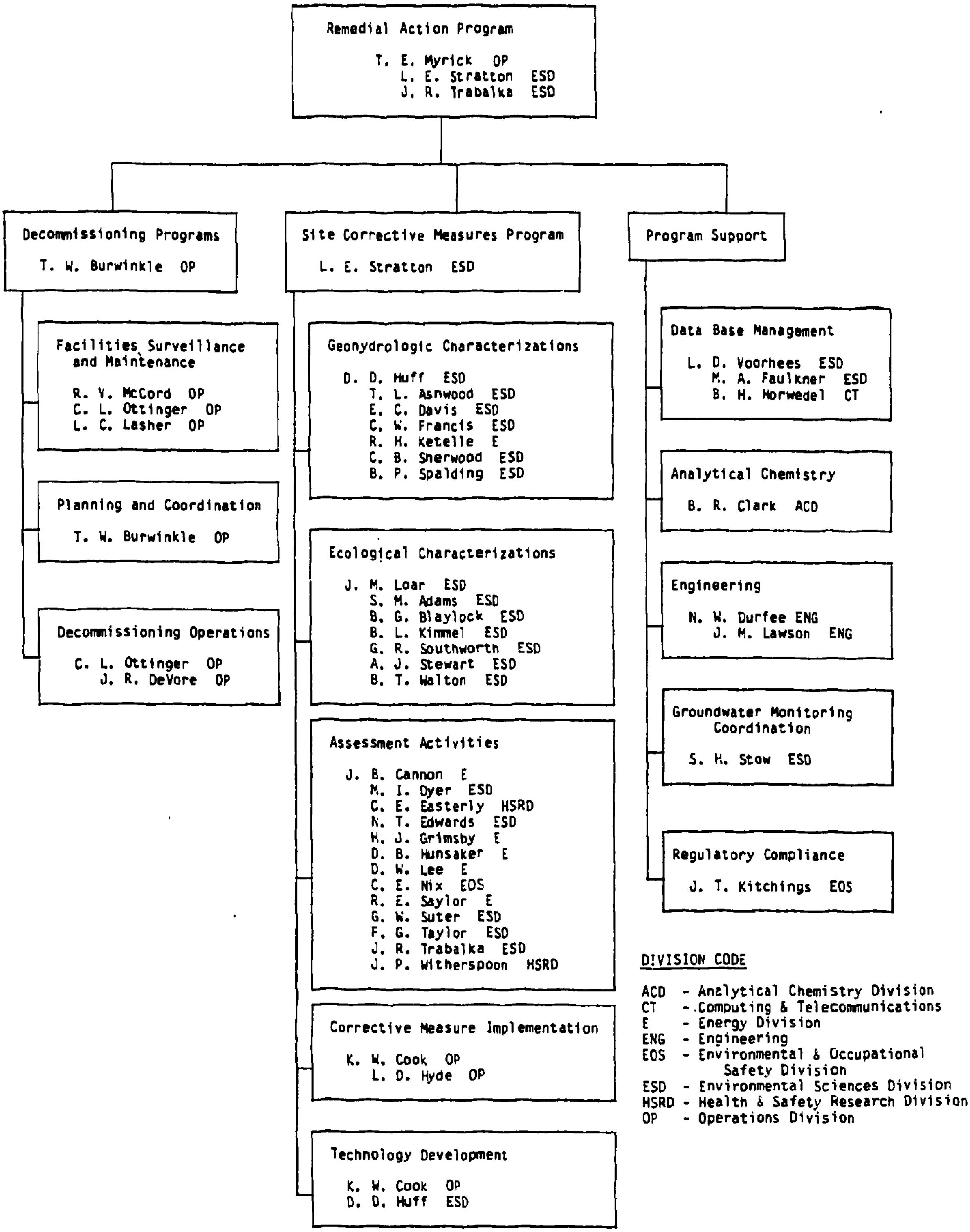

Fig. 1. Organization chart for the RA Program.

2. MANAGEMENT TEAM AND SERVICES

The DBM system is operated within the Environmental Sciences Division by a task leader, a data coordinator, and a computer programmer. The task leader (1) defines the needed DBM tasks by interacting with program management, characterization, and assessment staff; (2) initiates each task and certifies that all day-to-day operations proceed as expected; (3) encourages communication between other RA staff where DBM is involved (e.g., ensures that the data collected by characterization staff provide the information required by assessment staff and that the data are stored in a retrievable format); and (4) provides these DBM support activities within a specified budget.

The data coordinator carries out DBM operations on a day-to-day basis. This includes (1) keeping a log of all data received, (2) supervising data entry, (3) conducting the data verification and quality assurance procedures (Sects. 3.2 and 5.0), and (4) providing printouts and/or manipulations of data as requested by management and assessment staff. This position involves a small amount of programming, occasional keyboarding (extensive keyboarding is performed under arrangement with other ORNL divisions), and preparing summary statistics for program progress reports.

The computer programmer provides data manipulation and program development beyond that performed by the data coordinator. For example, during the early stages of the RA Program, much of the computer programmer's efforts have been aimed at developing an automated system for copying and manipulating data produced by the Analytical Chemistry Division, so that (1) staff time for transcribing data from printed report sheets is minimized and (2) errors of transcription do not compromise the accuracy of RA Program data. The programmer also devotes considerable effort towards converting data files originating outside the RA Program (and, in some cases, ORNL) into a format consistent with the data base for the program. For example, arrangements have been made to receive data tapes from the U.S. Geological Survey (USGS) and to read them into the data base (a more detailed discussion appears in Sect. 4.6).

Printouts of raw data and formal data sets are provided to the principal investigators (P.I.s) routinely for information and verification purposes (Sect. 3.2). In addition, DBM staff provide data summaries in various formats upon request from program staff. Requests originating outside ORNL (e.g., Environmental Protection Agency or Tennessee Department of Health and Environment) must be made through official channels. It is recognized that both internal and external data requests could become so voluminous in the future that additional DBM staff may be required.

The primary purpose of the DBM activity is to provide for a complete, well-documented, verified data base for the RA Program. Analyses of such data are primarily the responsibility of those who use the data; however, DBM staff will assist in such analyses as time and budget permit. Summary statistics (e.g., minimum, maximum, mean, standard deviation, etc.), plots, graphs, and a wide variety of other outputs are available using the current software system (Sect. 3.1). Specific capabilities of the software can be discussed with the investigator at the time of the request. Specialized data analyses and plots not supported by the data management software will be handled on a case-by-case basis. For some tasks, it is expected that DBM staff will assist in providing the necessary product; for others, it is more efficient and cost-effective to have DBM provide only the formatted data as input to another investigative team (e.g., see Sect. 4.6).

As the RA Program matures and the data base increases in size and complexity, it would be desirable to expand DBM's role in data analyses. No other group will be as familiar with the entire data base as the DBM staff, and it will be especially important to provide analyses that integrate the data from various tasks of the program. Such analyses require the involvement of staff who are thoroughly familiar with all data sets in the data base, to provide for hypotheses testing, display, and manipulation of spatial information. For example, it would be desirable to couple hydrologic flow data for the ORNL site to the results of the contaminant surveys in White Oak Creek, or to analyze the results of the aquatic toxicity and in-stream monitoring studies in relation to the sources of potential contamination. The DBM staff would work in close support of the characterization and assessment staff. We feel that future involvement of DBM staff in data analyses should be encouraged.

In an effort to be aware of current and future data base needs of the RA Program, current year work plans and other planning documents are reviewed by the DBM task leader as they become available. Also, Program monthly reports are read with an emphasis of identifying tasks that will generate data and/or need the input of data maintained in the data base. Such notations are discussed with the appropriate P.I. and/or RA task leader to ensure that plans are made to handle the data in a timely, efficient manner. A preliminary summary of the ecological and geohydrological characterization activities currently being planned for the program is presented in Sect. 4.9. In addition to the current DBM tasks (see Sects. 4.1–4.8 for examples), this summary illustrates the variety and magnitude of the data to be generated within the RA Program.

3. DESIGN OF THE DATA BASE

The data base system is designed to take advantage of the power of computer systems as an aid in acquiring, checking, and processing data so that accurate, representative information will be available for analysis and assessment. The design of the system was based primarily on anticipated applications and available data management systems.

Central to the entire RA Program, the DBM system will serve as a unified repository for all data. Specifically, the data will be used to evaluate the condition of the environment as it relates to ORNL's past waste management practices and research activities. For example, data from characterization studies will be used to determine the placement of monitoring wells required by the regulations, and ORNL's Environmental and Occupational Safety Division will have access to information contained in the data base for providing periodic reports to regulatory agencies as required by law. In addition, the data base will be available for use by staff responsible for the preparation of documents required by the National Environmental Policy Act. The flexibility and versatility of the data base design, described below, will help ORNL staff deal with compliance requirements as they arise.

3.1 DATA BASE MANAGEMENT SYSTEM

The data base uses the Statistical Analysis System (SAS) installed on the ORNL tandem IBM-3033 computers. SAS, developed by a private company devoted to the support and development of software and related services, is a popular and accepted scientific data management/analysis software package with over 20,000 installations worldwide. In addition to its compatibility with IBM computers and several minicomputers (e.g., VAX, Data General), SAS is available for the IBM PC/XT and AT microcomputers. The primary strength of SAS is its ability to combine data management capabilities with extensive statistical and graphical capabilities essential for the management of scientific data. In addition, SAS is highly versatile in handling information, both in its data management and report-writing capabilities. Using SAS, files can be produced in various formats for loading into other computer systems and for the very specialized data analyses and graphic displays not offered by SAS itself. Although SAS is not a true data management system per se (e.g., it lacks built-in capabilities for hierarchical and relational file structures), such data management systems do not have the extensive statistical and graphical capabilities of SAS. SAS can be operated through a sophisticated interactive access mode or through a batch mode.

3.2 DATA FLOW AND ORGANIZATION

Data for the RA Program are generated by a variety of sources, including ORNL's Analytical Chemistry Division (ACD), subcontractors (e.g., MCI Consulting Engineers), P.I.s, etc. Before the data become part of the data base available for interpretation, they are handled as three different data sets: (1) raw data, (2) unverified SAS data sets, and (3) verified SAS data sets. Transfer of the raw data into a verified SAS data set is described in the following example for data generated by the ACD.

When DBM receives a printout of ACD raw data, a copy is sent to the P.I. responsible for generating the data for his/her information. DBM enters the ACD data into a SAS format, adding additional information such as extraction procedures, analytical methods, task leader directing the work, etc. At this point, the data are part of what is referred to as the unverified data base. The data are subjected to SAS programs to check for impossible or unrealistic values, as part of DBM's quality assurance procedures (Sect. 5.0). The P.I. responsible for the data is then given a printout of the SAS data set and asked to verify the data within a specified time period (generally one week, but can vary depending on extent of the data set). Basically, this procedure consists of visually checking the data for unreasonable entries. For example, a pH of 11 may be possible, but unreasonable, for the system being studied. After the P.I. has checked the SAS data set, it is incorporated into what is referred to as the verified data base.

Similar procedures are used for data received from other sources. For example, data keyed for a P.I. are printed in raw form and given to the P.I. for information purposes. The data are then written as a SAS data set, subjected to a series of error checking routines, printed, sent to the P.I. for concurrence, and ultimately incorporated into the verified data base.

The data base consists of multiple data sets. Current and anticipated files are listed in Table 1. Although the present system contains only data collected since the RA Program was initiated,

Table 1. Current and anticipated contents of the RA Program data base

Site descriptors
Well documentation
Groundwater hydrology
Periodic collection
Continuous readers
Groundwater quality
Characterization for well placement
Compliance monitoring
Geology/Soils
Borehole contaminant analyses
Surface water hydrology
Surface water quality
Streambed surveys
White Oak Lake sediments
Ecological characteristics
Aquatic biota
Terrestrial biota
Toxicity surveys
Aquatic contaminants
Terrestrial contaminants
Biological indicators
Contaminated wastes
Pond water
Pond sediments
Tank contents
Numeric standards
Bibliographic information

pertinent historical information can be added as needed. In addition to the data generated within the RA Program, several data sets (e.g., waste inventory, air quality, NPDES monitoring) maintained by other groups/programs at ORNL have direct relevance to the remedial action activities. However, such data will be transferred to the RA Program data base only if needed. In most cases, this information should be available from the group responsible for its collection.

Currently there are more than 140 corrective action sites of widely ranging characteristics within the RA Program. Therefore, unique and concise identification codes (IDs) are assigned to all sites and samples. Sample IDs, used as key identifiers between various data sets, are cross-referenced to site names, latitude/longitude coordinates, and other identifiers within the site descriptor file. The ability to link data sets using key identifiers eliminates the need to store redundant information in each record and allows the data base to be flexible enough to incorporate additional components into the system as needed without disturbing the existing files. In addition to the manipulated files, raw data sets are maintained as a backup for historical reference and validation purposes (discussed further in Sect. 5.0).

3.3 APPLICATIONS

In addition to serving as a unified repository of all remedial action data, the data base system can offer a wide variety of procedures for data manipulation and analysis using SAS software. The SAS "base" software provides tools for information storage and retrieval, data modification and programming, report writing, statistical analysis, and file handling. Additional SAS software products for graphics, data entry, operations research, and interfaces to other data bases can be integrated with the base SAS software, and SAS data sets can be produced in various formats as input data for non-SAS software applications. Specific capabilities of SAS can be found in the numerous user's guides (e.g., SAS 1985a, b, c) published by the SAS Institute.

Although DBM staff will assist in data analyses as time and budget permit, currently these analyses are primarily the responsibility of those who use the data directly. The data base is designed so that the P.I. and/or task leaders can access their data to perform their own analyses, whether it be with SAS or non-SAS software. The data base can be accessed by authorized users through the ORNL computer system or through magnetic tapes or diskettes prepared by the DBM staff. The interactive access mode uses SAS to provide retrieval, subsetting, merging, report writing, statistics, and graphics; tape or diskette copies of the data can be created in a format to meet the needs of the user.

4. DATA BASE MANAGEMENT TASKS

Examples of the DBM tasks currently being conducted are presented Sects. 4.1 through 4.8. Although future monitoring plans for ecological and geohydrological characterization of the remedial action sites are still being formulated, a preliminary summary of the anticipated characterization activities is presented in Sect. 4.9 to illustrate the variety and magnitude of the data to be generated within the RA Program.

4.1 TRANSFER OF EXISTING FILES

In situations where existing data relevant to the RA Program are available, arrangements are made to copy such files, along with appropriate documentation such as definitions of variables. Any changes or updates required to make the file more useful for RA tasks are then performed. For example, a System 1022 file created by Dr. William J. Boegly, Jr., of ORNL's Environmental Sciences Division that describes existing wells at the X-10 site (location, depth, construction, etc.) has been transferred to the data base for the RA Program; a portion of this file and the corresponding SAS data set are shown in Figs. 2a and 2b. It should be noted that information for this file was compiled from historical records only and that the data have not been field checked or otherwise verified. Some of the data (e.g., well locations, status) are suspected or known to be erroneous. Thus, although some of these wells have been sampled to assist in designing a comprehensive monitoring program to comply with current regulations,

```
N-343    1 51  19263.000  25890.000  165.00000  1959.0000  .00000000  .00000000          OPEN            825.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SHEET.  DATA FROM WEEREN INVENTORY.

N-399    1 51  19319.000  25890.000  165.00000  1959.0000  .00000000  .00000000          OPEN            825.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SHEET.  DATA FROM WEEREN INVENTORY.

N-449    1 51  19369.000  25890.000  167.00000  1959.0000  .00000000  .00000000          OPEN            827.00000  .00000000  .00000
000 0   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY.

NE-359   1 51  19173.000  26143.000  200.00000  1959.0000  .00000000  .00000000          OPEN            820.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DEPTH APPROXIMATE.  GROUT SHEET.  DATA FROM WEEREN INVENTORY.

NE-410   1 51  19210.000  26180.000  200.00000  1959.0000  .00000000  .00000000          OPEN            825.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DEPTH APPROXIMATE.  DATA FROM WEEREN INVENTORY.

E-37     1 51  18920.000  25927.000  307.00000  1959.0000  .00000000  .00000000          OPEN            817.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SHEET.  DATA FROM WEEREN INVENTORY.

E-199    1 51  18920.000  26089.000  200.00000  1959.0000  .00000000  .00000000          OPEN            800.00000  .00000000  .00000
000 0   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  PLUGGED WITH SAND.  DATA IS FROM WEEREN INVENTORY.

E-273    1 51  18920.000  26163.000  237.00000  1959.0000  .00000000  .00000000          OPEN            797.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SEAM.  DATA FROM WEEREN INVENTORY.

E-362    1 51  18920.000  26252.000  330.00000  1959.0000  .00000000  .00000000          OPEN            810.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY

S-88     1 51  18832.000  25890.000  360.00000  1959.0000  .00000000  .00000000          OPEN            813.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SEAM.  DATA FROM WEEREN INVENTORY.

S-134    1 51  18736.000  25890.000  300.00000  1959.0000  .00000000  .00000000          OPEN            810.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY.

S-202    1 51  18718.000  25890.000  300.00000  1959.0000  .00000000  .00000000          OPEN            805.00000  .00000000  .00000
000 0   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  PLUGGED WITH SAND.  DATA FROM WEEREN INVENTORY.

W-79     1 51  18920.000  25811.000  300.00000  1959.0000  .00000000  .00000000          OPEN            805.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SEAM.  DATA FROM WEEREN INVENTORY.

W-127    1 51  18920.000  25763.000  340.00000  1959.0000  .00000000  .00000000          OPEN            800.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY.

W-184    1 51  18920.000  25706.000  360.00000  1959.0000  .00000000  .00000000          OPEN            800.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORT.

W-200    1 51  18920.000  25690.000  200.00000  1959.0000  .00000000  .00000000          OPEN            800.00000  .00000000  .00000
000 0   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  PLUGGED WITH SAND.  DATA FROM WEEREN INVENTORY.

W-237    1 51  18920.000  25653.000  325.00000  1959.0000  .00000000  .00000000          OPEN            800.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY.

W-309    1 51  18920.000  25581.000  333.00000  1959.0000  .00000000  .00000000          OPEN            808.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  DATA FROM WEEREN INVENTORY.

NW-259   1 51  19156.000  25790.000  154.00000  1959.0000  .00000000  .00000000          OPEN            813.00000  .00000000  .00000
000 1   .00000000 SURFACE CASING, BALANCE IS OPEN HOLE.  GROUT SHEET.  DEPTH IS LISTED AS GREATER THAN.  DATA FROM WEEREN INVENTORY.
```

Fig. 2a. Portion of existing 1022 file of groundwater monitoring wells, compiled by W. J. Boegly, Jr.

GROUNDWATER WELLS

WELL	AREA CODE	ORNL NS	ORNL EW	DEPTH	DIAMETER	CASING DEPTH	CASING TYPE	SCREEN	SCREEN INTERVAL	SURFACE ELEVATION	MEASURING PT. CORR.	TOP CASING ELEVATION	STATUS
E-100	52	16793	31355	910	0.00	0		OPEN		788	0	0	1
E-199	51	18920	26089	200	0.00	0		OPEN		800	0	0	0
E-200	52	16772	31450	900	0.00	0		OPEN		789	0	0	1
E-2000W	54	16503	28378	1130	2.88	0				788	0	0	1
E-200RC	54	16483	28377	650	4.00	550	S			735	0	0	1
E-273	51	18920	26163	287	0.00	0		OPEN		797	0	0	1
E-300RC	53	17003	28893	650	4.00	600	S			783	0	0	1
E-320	53	17013	23921	840	2.88	0				782	0	0	1
E-320P	53	16999	23924	500	4.00	0	S			782	0	0	1
E-362	51	18920	26252	330	0.00	0		OPEN		810	0	0	1
E-37	51	18920	25927	307	0.00	0		OPEN		817	0	0	1
E-400	52	16719	31645	900	0.00	0		OPEN		794	0	0	1
E-500	52	16686	31750	900	0.00	0		OPEN		798	0	0	1
E-600	52	16666	31849	900	0.00	0		OPEN		794	0	0	1
INJECT1	51	18920	25890	300	3.50	300				816	0	0	1
INJECT2	52	16817	31260	940	4.50	940	S	NONE		790	0	0	0
INJECT3	53	17155	28617	1080	0.00	0		NOTES		799	0	0	1
INJECT4	54	16502	28178	990	0.00	0				789	0	0	1
JOY	51	19146	25905	220	0.00	0		OPEN		820	0	0	1
N-100	53	17255	28617	1000	1.25	1000	S			786	0	0	1
N-150	53	17310	28611	1050	2.38	1050	S			786	0	0	1
N-199	51	19119	25890	200	0.00	0		OPEN		820	0	0	1
N-200	52	17013	31287	815	0.00	0		OPEN		800	0	0	1
N-2000W	54	16702	28178	1072	2.88	0				771	0	0	1
N-200RC	53	17360	28646	650	4.00	500	S			792	0	0	1
N-200RC	54	16702	29158	580	4.00	480	S			770	0	0	1
N-231	51	19151	25390	200	0.00	0		OPEN		820	0	0	1
N-275RC	53	17430	28616	600	4.00	500	S			777	0	0	1
N-343	51	19263	25890	165	0.00	0		OPEN		825	0	0	1
N-375P	53	17522	28605	500	4.00	0	S			772	0	0	1
N-399	51	19319	25890	165	0.00	0		OPEN		825	0	0	1
N-400	52	17217	31290	780	0.00	0		OPEN		824	0	0	1
N-449	51	19369	25390	147	0.00	0		OPEN		827	0	0	0
N-600	52	17410	31290	700	0.00	0		OPEN		834	0	0	1
NE-100	53	17225	28690	1040	4.00	500	S			795	0	0	1
NE-125	53	17245	28708	1030	1.25	0				801	0	0	0
NE-125RC	53	17227	28723	600	4.00	500	S			800	0	0	1
NE-200	52	15918	31441	840	0.00	0		OPEN		793	0	0	1
NE-200RC	53	17300	28762	600	4.00	500	S			806	0	0	1
NE-283RC	54	16673	28367	580	4.00	480	S			765	0	0	1
NE-300	52	16962	31515	860	0.00	0		OPEN		799	0	0	1
NE-300P	53	17378	29839	500	4.00	0				816	0	0	1
NE-359	51	19173	26143	200	0.00	0		OPEN		820	0	0	1
NE-400	52	17026	31600	820	0.00	0		OPEN		799	0	0	1

AREA CODES

03	SWSA-3 AREA	04	SWSA-4 AREA	05	SWSA-5 AREA
06	SWSA-6 AREA	07	SWSA-7 AREA	82	PITS AND TRENCHES AREA
90	NORTH OF SWSA-6	92	RIDGE NORTH OF SWSA-5	99	ORNL PLANT AREA

STATUS CODES

0 DAMAGED OR DESTROYED 1 ACTIVE(UNDAMAGED)

Fig. 2b. Portion of SAS data set of groundwater monitoring wells at X-10 site, compiled by W. J. Boegly, Jr.

the well construction information associated with all of the wells in this file cannot be released for unrestricted use at this time. Descriptive data for all new wells specifically constructed for the RA Program will be added to the well construction SAS data set as they become available (Sect. 4.5).

4.2 TRANSFER OF ANALYTICAL RESULTS

All RA Program samples taken for chemical or radiological analyses (e.g., pond sediment, pond water, well water, soil cores, streambed gravel) are submitted to ORNL's Analytical Chemistry Division (ACD). The results of such analyses are maintained on an ACD System 1022 data base at ORNL. To avoid manual transfer of data from ACD report sheets by transcribing, keypunching, keyboarding, etc. (which would take considerable time and introduce an additional source of error), such data are transferred electronically from ACD files into the RA Program data base. Because the samples are analyzed by several ACD laboratories (e.g., radionuclides, organics), and each laboratory enters the data in a slightly different form, it has been necessary to write software to convert the various ACD data sets to a common SAS format to provide for data manipulation and display. Until the ACD laboratories enter the data in a consistent format, it will be necessary to use algorithms to extract the necessary information. Figures 3a and 3b show a portion of an ACD report sheet and the reformatted SAS data set created from it.

ANALYTICAL RESULTS - 09/19/85 PAGE 1 APPROVED: [signature]

CUSTOMER : D.CLARA/ENFD
ADDRESS : 45205
PHONE : 46596
REQUEST : 2995
RECEIVED : 07/12/85
COMMENTS : ALL UNITS MG/L UNLESS OTHERWISE STATED

CHARGE : 3380425
SERIES :
COMPLETED : 09/19/85

SAMPLE IDS	LAB #	AG	AL	AS	B	BA	BE	CA	CD	CO	CR
WAT[illegible] 5495*	[illegible]	<0.050 UG/ML	<0.20 UG/ML	<0.10 UG/ML	<0.060 UG/ML	0.050 UG/ML	<0.0020 UG/ML	67. UG/ML	<0.0050 UG/ML	0.012 UG/ML	<0.040 UG/ML
		CU	**FE**	**GA**	**HF**	**K**	**LI**	**MG**	**MN**	**MO**	**NI**
		<0.020 UG/ML	[illegible] UG/ML	<0.30 UG/ML	<0.040 UG/ML	2.0 UG/ML	<0.20 UG/ML	10. UG/ML	0.15 UG/ML	<0.040 UG/ML	<0.060 UG/ML
		P	**PB**	**SB**	**SE**	**SI**	**SR**	**TI**	**V**	**ZN**	**ZR**
		<0.30 UG/ML	<0.20 UG/ML	<0.20 UG/ML	<0.20 UG/ML	4.4 UG/ML	0.090 UG/ML	<0.020 UG/ML	0.021 UG/ML	<0.020 UG/ML	<0.020 UG/ML
		NA									
		11[illegible]. UG/ML									

SAMPLE IDS	LAB #	AG	AL	AS	B	BA	BE	CA	CD	CO	CR
WAT[illegible] 5504*	[illegible]	<0.050 UG/ML	<0.20 UG/ML	<0.10 UG/ML	<0.080 UG/ML	0.066 UG/ML	<0.0020 UG/ML	45. UG/ML	<0.0050 UG/ML	<0.010 UG/ML	<0.040 UG/ML
		CU	**FE**	**GA**	**HF**	**K**	**LI**	**MG**	**MN**	**MO**	**NA**
		<0.020 UG/ML	[illegible].36 UG/ML	<0.30 UG/ML	<0.040 UG/ML	2.3	<0.20 UG/ML	11. UG/ML	0.14 UG/ML	<0.040 UG/ML	17. UG/ML
		NI	**P**	**PB**	**SB**	**SE**	**SI**	**SR**	**TI**	**V**	**ZN**
		<0.060 UG/ML	<0.3[illegible] UG/ML	<0.20 UG/ML	<0.20 UG/ML	<0.2[illegible] UG/ML	4.6 UG/ML	0.077 UG/ML	<0.020 UG/ML	0.023 UG/ML	<0.020 UG/ML
		ZR									
		<0.020 UG/ML									

SAMPLE IDS	LAB #	AG	AL	AS	B	BA	BE	CA	CD	CO	CR
WAT [illegible] 5507*	[illegible]	<0.050 UG/ML	<0.20 UG/ML	<0.10 UG/ML	<0.080 UG/ML	0.062 UG/ML	<0.0020 UG/ML	64. UG/ML	<0.0050 UG/ML	<0.010 UG/ML	<0.040 UG/ML
		CU	**FE**	**GA**	**HF**	**K**	**LI**	**MG**	**MN**	**MO**	**NA**

Fig. 3a. Example of results sheet from Analytical Chemistry Division.

ERFU FILE OF ANALYTICAL CHEMISTRY RESULTS

REQUEST NUMBER	CUSTOMER SAMPLE ID	SAMPLE DATE	ANALYSIS	PREFIX	RESULT	UNITS	LIMITS	EXTRACTION TECHNIQUE	METHOD
52995	WATE-8.8.85-5495	09/19/85	AG	<	0.050	UG/ML	.		ICP
			AL	<	0.200	UG/ML	.		ICP
			AS	<	0.100	UG/ML	.		ICP
			B	<	0.080	UG/ML	.		ICP
			BA		0.050	UG/ML	.		ICP
			BE	<	0.002	UG/ML	.		ICP
			CA		67.000	UG/ML	.		ICP
			CD	<	0.005	UG/ML	.		ICP
			CO		0.012	UG/ML	.		ICP
			CR	<	0.040	UG/ML	.		ICP
			CU	<	0.020	UG/ML	.		ICP
			FE		0.330	UG/ML	.		ICP
			GA	<	0.300	UG/ML	.		ICP
			HF	<	0.040	UG/ML	.		ICP
			K		2.000	UG/ML	.		ICP
			LI	<	0.200	UG/ML	.		ICP
			MG		10.000	UG/ML	.		ICP
			MN		0.150	UG/ML	.		ICP
			MO	<	0.040	UG/ML	.		ICP
			NI	<	0.060	UG/ML	.		ICP
			P	<	0.300	UG/ML	.		ICP
			PB	<	0.200	UG/ML	.		ICP
			SB	<	0.200	UG/ML	.		ICP
			SE	<	0.200	UG/ML	.		ICP
			SI		4.400	UG/ML	.		ICP
			SR		0.090	UG/ML	.		ICP
			TI	<	0.020	UG/ML	.		ICP
			V		0.021	UG/ML	.		ICP
			ZN	<	0.020	UG/ML	.		ICP
			ZR	<	0.020	UG/ML	.		ICP
			NA2		110.000	UG/ML	.		ICP
52995	WATE-8.8.85-5504	09/19/85	AG	<	0.0500	UG/ML	.		ICP
			AL	<	0.2000	UG/ML	.		ICP
			AS	<	0.1000	UG/ML	.		ICP
			B	<	0.0800	UG/ML	.		ICP
			BA		0.0680	UG/ML	.		ICP
			BE	<	0.0020	UG/ML	.		ICP
			CA		45.0000	UG/ML	.		ICP
			CD	<	0.0050	UG/ML	.		ICP
			CO	<	0.0100	UG/ML	.		ICP
			CR	<	0.0400	UG/ML	.		ICP
			CU	<	0.0200	UG/ML	.		ICP
			FE		0.3600	UG/ML	.		ICP
			GA	<	0.3000	UG/ML	.		ICP
			HF	<	0.0400	UG/ML	.		ICP
			K		2.3000	MG/L	.		ICP
			LI	<	0.2000	UG/ML	.		ICP
			MG		11.0000	UG/ML	.		ICP
			MN		0.1400	UG/ML	.		ICP
			MO	<	0.0400	UG/ML	.		ICP

Fig. 3b. Portion of SAS data set of Analytical Chemistry Division results.

4.3 FORMATTING FIELD DATA

When individual researchers have field observations that are relevant to the RA Program, the DBM staff assists them with getting the data into computerized form so that the information can ultimately be incorporated into the data base. Depending on the computer experience of the researcher, this may also involve assisting in the design of field data sheets. The goal is to design the forms such that they can be completed easily in the field or laboratory and also be directly keyed for computer use without transcribing the data. In cooperation with the researcher, various checks can be incorporated into the field sheets and data entry procedures to assist in maintaining quality assurance (see Sect. 5.0). Figures 4a and 4b show raw field data as recorded by Dr. Thure Cerling of the Department of Geology, University of Utah, and the resulting SAS data set. In this case, a file was created from an earlier publication by Cerling and Spalding (1981) to relate sampling sites as recorded by Cerling to standard ORNL grid coordinates to enable the data to be mapped.

4.4 MERGING RELATED FILES

In many cases, data from one SAS file must be merged with that from another SAS file. This is done most easily when the need has been anticipated and the separate files contain a common variable to allow merging. For example, the analytical data and field data of Cerling (discussed above and shown in Figs. 3 and 4) can be joined, using sample ID as the common variable. The result is shown in Figure 5.

	1	2	3		
1	5401		SWSA 7	—	GRAV
2	5402	19 JUL 85	MS 4	D156	SORB
3	5403		MS 4	D156	CLAM
4	5404		MS 2A	D39	CLAM
5	5405		JKL	—	CLAM
6	5406		MS 2A	D40	SORB
7	5407		SWSA 4	D108	SORB
8	5408		MS 3	D68	SORB
9	5409		MS 3	D68	GLASS
10	5410		MS 4	D158	SORB
11	5411		MS 4	D158	GLASS
12	5412		MS 4A	D129	SORB
13	5413		MS 4B	D197	SORB
14	5414		MS 4B	D197	GLASS
15	5415		HFIR	D177	SORB
16	5416		HFIR	D177	SORB
17	5417		HFIR	D172	SORB
18	5418		SWSA 7	—	SORB
19	5419		T345	D305	SORB
20	5420		SWSA6E	D241	SORB
21	5421		JKL	—	SORB
22	5422		JKL	—	GLASS
23	5423		COOL	—	SORB
24	5424		NWT	D292	SORB
25	5425	23 JUL 85	MS 2	D12	SORB
26	5426		MS 2	D12	GRAV
27	5427		3RD ST	D21	SORB
28	5428		3RD ST	D21	GRAV
29	5429		SWSA 4	D103	GRAV
30	5430	24 JUL 85	SWSA 4	D103	SORB
31	5431		SWSA 4	D103	GLASS
32	5432		MS 3	D68	GRAV
33	5433		WOC	D70	GRAV
34	5434		JKL	—	GRAV
35	5435		COOL	—	GRAV
36	5436		SWSA 6	D350	SORB
37	5437		SWSA 6	D350	GRAV
38	5438		MISC	D341	GRAV
39	5439	25 JUL 85	SWSA 6E	D241	GRAV
40	5440		T345	D305	GRAV

Fig. 4a. Example of field data sheet as submitted by an investigator.

ID	DATE	SITE	SITENO	TYPE	NORTH	EAST
5401	19JUL85	SWSA7		GRAV	1600	33360
5402	19JUL85	MS4	D156	SORB	16875	28310
5403	19JUL85	MS4	D156	CLAM	16875	28310
5404	19JUL85	MS2A	D39	CLAM	19845	29520
5405	19JUL85	JKL		CLAM	24120	37980
5406	19JUL85	MS2A	D40	SORB	19750	29470
5407	19JUL85	SWSA4	D108	SORB	18675	28780
5408	19JUL85	MS3	D68	SORB	17200	28045
5409	19JUL85	MS3	D68	GLASS	17200	28045
5410	19JUL85	MS4	D158	SORB	16865	28085
5411	19JUL85	MS4	D158	GLASS	16865	28085
5412	19JUL85	MS4A	D129	SORB	16675	31125
5413	19JUL85	MS4B	D197	SORB	17720	30935
5414	19JUL85	MS4B	D197	GLASS	17720	30935
5415	19JUL85	HFIR	D177	SORB	16315	32555
5416	19JUL85	HFIR	D177	SORB	16315	32555
5417	19JUL85	HFIR	D172	SORB	16650	32835
5418	19JUL85	SWSA7		SORB	24120	37980
5419	19JUL85	T345	D305	SORB	16875	26265
5420	19JUL85	SWSA6E	D241	SORB	16920	25340
5421	19JUL85	JKL		SORB	24120	37980
5422	19JUL85	JKL		GLASS	24120	37980
5423	19JUL85	COOL		SORB	24120	37980
5424	19JUL85	NWT	D292	SORB	20630	29640
5425	23JUL85	MS2	D12	SORB	21165	31365
5426	23JUL85	MS2	D12	GRAV	21165	31365
5427	23JUL85	3RDST	D21	SORB	21140	30710
5428	23JUL85	3RDST	D21	GRAV	21140	30710
5429	23JUL85	SWSA4	D103	GRAV	18890	28300
5430	24JUL85	SWSA4	D103	SORB	18890	28300
5431	24JUL85	SWSA4	D103	GLASS	18890	28300
5432	24JUL85	MS3	D68	GRAV	17200	28045
5433	24JUL85	WOC	D70	GRAV	17090	27880
5434	24JUL85	JKL		GRAV	24120	37980
5435	24JUL85	COOL		GRAV	24120	37980
5436	24JUL85	SWSA6	D350	SORB	16050	23890
5437	24JUL85	SWSA6	D350	GRAV	16050	23890
5438	24JUL85	MISC	D341	GRAV	17020	24100
5439	25JUL85	SWSA6E	D241	GRAV	16920	25340
5440	25JUL85	T345	D305	GRAV	16875	26265
5441	25JUL85	MS4	D158	GRAV	16865	28085
5442	25JUL85	MS4	D159	GRAV	16895	27990
5443	25JUL85	HFIR	D177	GRAV	16315	32555

Fig. 4b. Portion of SAS data set showing field data.

ERFU FILE OF MERGED FIELD DATA AND ANALYTICAL DATA

CERLING SAMPLE ID	SITE	SITENO	DATE	TYPE	NORTH	EAST	ANALYSIS	PREFIX	RESULT	UNITS	LIMITS	EXTRACTION	METHOD
5624	MS3	D68	08/09/85	WFIL	17200	28045	CR	<	0.0400	UG/ML	.		ICP
							CU	<	0.0200	UG/ML	.		ICP
							FE		0.0890	UG/ML	.		ICP
							GA	<	0.3000	UG/ML	.		ICP
							HF	<	0.0400	UG/ML	.		ICP
							K		2.8000	UG/ML	.		ICP
							LI	<	0.2000	UG/ML	.		ICP
							MG		12.0000	UG/ML	.		ICP
							MN		0.0640	UG/ML	.		ICP
							MO	<	0.0400	UG/ML	.		ICP
							NA		25.0000	UG/ML	.		ICP
							NI	<	0.0600	UG/ML	.		ICP
							P	<	0.3000	UG/ML	.		ICP
							PB	<	0.2000	UG/ML	.		ICP
							SB	<	0.2000	UG/ML	.		ICP
							SE	<	0.2000	UG/ML	.		ICP
							SI		2.5000	UG/ML	.		ICP
							SR		0.0900	UG/ML	.		ICP
							TI	<	0.0200	UG/ML	.		ICP
							V	<	0.0100	UG/ML	.		ICP
							ZN		0.0650	UG/ML	.		ICP
							ZR	<	0.0200	UG/ML	.		ICP
							SO4		62.0000	UG/ML	.		ICP
							CL		35.0000	UG/ML	.		ICP
							CD	<	1.0000	PPB	.		POLAR
							PB	<	2.0000	PPB	.		POLAR
5629	MB	D141	08/09/85	GRAV	16700	29855	AG	<	0.5000	UG/G	.	NH2OHHCL	ICP
							AL		440.0000	UG/G	.	NH2OHHCL	ICP
							AS	<	1.0000	UG/G	.	NH2OHHCL	ICP
							B		4.5000	UG/G	.	NH2OHHCL	ICP
							BA		140.0000	UG/G	.	NH2OHHCL	ICP
							BE		0.0410	UG/G	.	NH2OHHCL	ICP
							CA		3300.0000	UG/G	.	NH2OHHCL	ICP
							CO	<	0.0500	UG/G	.	NH2OHHCL	ICP
							CD		11.0000	UG/G	.	NH2OHHCL	ICP
							CR		11.0000	UG/G	.	NH2OHHCL	ICP
							CU		5.4000	UG/G	.	NH2OHHCL	ICP
							GA	<	3.0000	UG/G	.	NH2OHHCL	ICP
							K		120.0000	UG/G	.	NH2OHHCL	ICP
							LI	<	2.0000	UG/G	.	NH2OHHCL	ICP
							MG		380.0000	UG/G	.	NH2OHHCL	ICP
							MO		4.2000	UG/G	.	NH2OHHCL	ICP
							NA		25.0000	UG/G	.	NH2OHHCL	ICP
							NI		5.3000	UG/G	.	NH2OHHCL	ICP
							P		150.0000	UG/G	.	NH2OHHCL	ICP
							PB	<	2.0000	UG/G	.	NH2OHHCL	ICP
							SB		5.3000	UG/G	.	NH2OHHCL	ICP
							SE	<	2.0000	UG/G	.	NH2OHHCL	ICP
							SI		100.0000	UG/G	.	NH2OHHCL	ICP
							SR		7.9000	UG/G	.	NH2OHHCL	ICP

Fig. 5. Example of field and analytical chemistry data sets that have been merged.

4.5 WELL CONSTRUCTION DATA

Four categories of monitoring wells will be installed at ORNL to characterize and monitor the groundwater in the vicinity of the remedial action sites: (1) groundwater characterization (piezometer) wells, (2) hydrostatic-head measuring stations, (3) groundwater quality monitoring wells, and (4) plume characterization wells. Well documentation data (e.g., identification number, location, elevation, depth, construction materials) associated with the installation of each well are recorded either on a personal computer diskette by a subcontractor or directly onto the ORNL computer system by Computing and Telecommunications staff at ORNL. The data are then transferred electronically to DBM's allocated computer space and formatted into a SAS data set. These data can then be merged with other SAS data sets (e.g., groundwater quality, hydrology) as needed.

4.6 HYDROLOGIC DATA

Knowledge of the direction and rate of groundwater flow is essential to the design of an effective groundwater monitoring program and is required for compliance with state and federal regulations. Such data are obtained primarily from the groundwater characterization (piezometer) wells and the hydrostatic-head measuring stations (Sect. 4.5). Additional hydrologic data are collected from the groundwater quality monitoring wells.

The piezometer and groundwater quality monitoring wells are sampled manually. These data are keyed and verified through error checking routines (see Sect. 5.0). Hydrologic data from the hydrostatistic head measuring stations will be recorded by continuous, automated readers maintained by the USGS. The field data (hourly records of groundwater elevation) will be transferred to magnetic tapes for storage. As a test case, the USGS provided a magnetic tape containing data of the type that will be produced for the RA Program. This information was successfully formatted as a SAS file at ORNL. Collection of data using this technique is expected to begin during the third quarter of FY 1986.

The groundwater hydrology data can be merged with well construction information (see Sect. 4.5), formatted, and used to plot groundwater surface contour maps of the area surveyed. Groundwater hydrologists in the Energy Division will produce the maps initially, using data from the RA Program data base. Other methods of data presentation are being investigated (e.g., USGS and ORNL Geographical Information System software).

4.7 NUMERIC STANDARDS

Numeric standards and criteria that have been identified from regulations as being relevant to the RA Program are maintained in the data base. Such files can be used for display in reports, and for comparison with analytical results from field sampling (e.g., what percentage of groundwater samples exceed a given standard for chromium?). An example of a regulatory numeric standard file is the State of Tennessee's Hazardous Substance Guidelines; Figs. 6a and 6b show these guidelines as received by ORNL and as the corresponding SAS data set.

Hazardous Substance Guidelines
Tennessee Division of Solid Waste Management - Superfund

Compound	Maximum limit, water ppm or mg/l	Maximum limit, soil ppm or mg/kg	Water Reference
Benzene	0.025	2.5	6
Ethylbenzene	1.4	140	1
Toluene	14.3	1430	1
Carbon tetrachloride	0.025	2.5	6
Chloroform	0.002	0.2	1
1,2-Dichloroethane	0.26	26	6
1,1-Dichloroethylene	0.35	35	6
Methylene chloride	0.15	15	2
Tetrachloroethylene	0.085	8.5	6
Trichloroethylene	0.26	26.0	6
1,1,1-Trichlorethane	1.0	100	6
Acetone	20	2,000	7
Ethylacetate	400	40,000	4
Xylenes	0.62	62	2
Methyl ethyl ketone	0.75	75	5
Methyl isobutyl ketone	100	10,000	4
Vinyl chloride	0.06	6.0	6
Naphthalene	0.025	2.0	1
Di-n-butyl phthalate	0.034	3.4	1
Pentachlorophenol	1.01	101	1
Cyanide	0.2	10 [illegible]	3,8
Phenol	0.3	30	1,8
Copper	1	100	3
Zinc	5	500	3,8
Nickel	0.2	20	3,8
Mercury	0.002	0.2	3,8
Arsenic	0.05	5	3,8
Cadmium	0.01	1.0	3,8
Chromium	0.05	5	3,8
Silver	0.05	5	3,8
Lead	0.05	5	3,8
PAH's [illegible] 1/100,000 0.01	0.000028	0.0028	1
PCB's " " "	0.00000079 [illegible] (.00079 µg/l)	0.000079	

Water limits, clarified by MED 8-28-84:
Nitrates (N)-10 ppm
Sulfates-250 ppm
phosphate - should be set below 50 ppm in water (gives renal damage in rats, is 10 times dietary, adequate nutritional level for rats)

References:

1. Federal Register, 45:231, Nov. 1980.
2. Long term SNARL
3. Interim Drinking Water Standard
4. Dangerous Properties of Industrial Materials. N. Irving Sax
5. 10-day SNARL
6. Federal Register, 49:114, 24338, June 1984.
7. Flash point concentration.
8. E.P. Toxicity limit or suggested level (Phenol, cyanide, nickel)

Margaret E. Dew, Ph.D.

Margaret E. Dew, Ph.D.
superfund Chief Chemist

MED/bec/H-1

[illegible] - 5432

Fig. 6a. Example of numeric standards as received by ORNL.

ERPU FILE OF NUMERIC STANDARDS

Constituent	Water Concentration	Water Units	Soil Concentration	Soil Units	Waste Concentration	Waste Units
Acetone	2.000E+01	mg/l	2.000E+03	mg/kg		
Arsenic	5.000E-02	mg/l	5.000E+00	mg/kg		
Benzene	2.500E-02	mg/l	2.500E+00	mg/kg		
Cadmium	1.000E-02	mg/l	1.000E+00	mg/kg		
Carbon tetrachloride	2.500E-02	mg/l	2.500E+00	mg/kg		
Chloroform	2.000E-03	mg/l	2.000E-01	mg/kg		
Chromium	5.000E-02	mg/l	5.000E+00	mg/kg		
Copper	1.000E+00	mg/l	1.000E+02	mg/kg		
Cyanide	2.000E-01	mg/l	2.000E+00	mg/kg	1.000E+01	mg/kg
Di-n-butyl phthalate	3.400E-02	mg/l	3.400E+00	mg/kg		
Ethylacetate	4.000E+02	mg/l	4.000E+04	mg/kg		
Ethylbenzene	1.400E+00	mg/l	1.400E+02	mg/kg		
Lead	5.000E-02	mg/l	5.000E+00	mg/kg		
Mercury	2.000E-03	mg/l	2.000E-01	mg/kg		
Methyl ethyl ketone	7.500E-01	mg/l	7.500E+01	mg/kg		
Methyl isobutyl ketone	1.000E+02	mg/l	1.000E+04	mg/kg		
Methylene chloride	1.500E-01	mg/l	1.500E+01	mg/kg		
Naphthalene	2.500E-02	mg/l	2.000E+00	mg/kg		
Nickel	2.000E-01	mg/l	2.000E+01	mg/kg		
Nitrate-N	1.000E+01	mg/l				
Pentachlorophenol	1.010E+00	mg/l	1.010E+02	mg/kg		
Phenol	3.000E-01	mg/l	3.000E+01	mg/kg		
Phosphate	5.000E+01	mg/l				
PAHs	2.800E-05	mg/l	2.800E-03	mg/kg		
PCBs	7.900E-07	mg/l	7.900E-05	mg/kg		
Silver	5.000E-02	mg/l	5.000E+00	mg/kg		
Sulfate	2.500E+02	mg/l				
Tetrachloroethylene	8.500E-02	mg/l	8.500E+00	mg/kg		
Toluene	1.430E+01	mg/l	1.430E+03	mg/kg		
Trichloroethylene	2.600E-01	mg/l	2.600E+01	mg/kg		
Vinyl chloride	6.000E-02	mg/l	6.000E+00	mg/kg		
Xylenes	6.200E-01	mg/l	6.200E+01	mg/kg		
Zinc	5.000E+00	mg/l	5.000E+02	mg/kg		
1,1-Dichloroethylene	3.500E-01	mg/l	3.500E+01	mg/kg		
1,1,1-Trichloroethane	1.000E+00	mg/l	1.000E+02	mg/kg		
1,2-Dichloroethane	2.600E-01	mg/l	2.600E+01	mg/kg		

Fig. 6b. Example of numeric standards in SAS data set.

4.8 BIBLIOGRAPHIC DATA

During the course of the project, many publications, regulations, DOE orders, etc., are identified as of interest to RA Program staff. In cooperation with staff (coordinated by Dr. Miriam Kertesz) of the Information Research and Analysis Section, Biology Division, a bibliographic data base of this information has been created using the Automated Data Set Editing Program (ADSEP) developed at ORNL.

There are three avenues of entry for citations into the bibliography. First, staff may currently hold publications that are relevant to the RA Program or know of their location; in this case, appropriate bibliographic descriptors are used to create the citations in the bibliography. The bibliography lists the location of the document, so that access to the document itself is possible through the indicated holder of the document; there is no central RA Program library of such holdings, and staff are not asked to surrender their holdings. Second, when a literature search is performed by assessment staff in the RA Program (the search itself is not within the realm of DBM), any useful publications identified in the search can be added to the bibliography. Third, when relevant existing bibliographies are identified, they can be merged with the bibliography (e.g., a bibliography covering ORNL surplus facilities has been identified and will be added to the bibliographic data base). Figure 7 presents a portion of the RA Program bibliography, illustrating the information describing each citation. The bibliography is updated periodically by (1) adding new citations and (2) correcting existing information such

<43> CONT.
areas. The radioactive-hazardous wastes are treated in two manners: storage of the waste until acceptable disposal options are developed, or treatment of the waste to remove or destroy one of the components prior to disposal. 5 references, 4 figures, 13 tables.
L.D. Voorhees Office, Bldg. 1505

<44>
US DOE, Office of Health and Environmental Research
Workshop on Subsurface Transport of Energy-Related Organic Chemicals, Bedminster, NJ, May 21-23, 1984
CONF-8405297-Summ; DOE/ER-0215
1984, Dec
This summary is intended for a scientific audience. It was assembled by Drs. George Pinder and William Gray of Princeton University to synthesize several days of scientific discussion about research issues in bioeochemistry and hydrology. Using a combination of scientific presentations and small group discussion, all participants at a seminar organized by Princeton University were exposed to scientific aspects of subsurface transport of organic chemicals that were peripheral to their primary research interests. Using this approach, a multidisciplinary view of long-term research needs emerged at the meeting. 37 references.
ESD Library

<45>
US DOE, Washington, DC, Office of Environmental Compliance and Overview
Environmental Compliance Guide
DOE/EV--0132(Vol.1)
1981, Feb
The Guide is intended to assist Department of Energy personnel by providing information on the NEPA process, the processes of other environmental statutes that bear on the NEPA process, the timing relationships between the NEPA process and these other processes, as well as timing relationships between the NEPA process and the development process for policies, programs, and projects. This information should be helpful not only in formulating environmental compliance plans but also in achieving compliance with NEPA and various environmental statutes. The Guide is divided into three parts with related appendices: Part I provides guidance for developing environmental compliance plans for DOE actions; Part II is devoted to NEPA with detailed flowcharts depicting the compliance procedures required by CEQ regulations and DOE NEPA guidelines; and Part III contains a series of flowcharts for other federal environmental requirements that may apply to DOE projects.
NTIS

Fig. 7. Portion of bibliography in RA Program data base.

as the location of a document. It is expected that the bibliography will serve to inform program staff of the existence and locations of useful publications and also be useful in generating lists of literature cited in RA Program reports.

4.9 FUTURE DATA

The RA Program was formed in mid-FY 1985. Thus, the vast majority of the monitoring programs to be conducted at the ORNL site are just now being planned. Nevertheless, to illustrate the types and extent of data which are expected to be included in the data base, summaries of the anticipated ecological and geohydrological characterization tasks are presented in Tables 2 and 3. It is emphasized that these summaries are very preliminary, as evidenced by the "?" (unknowns) listed in the tables.

The number of observations associated with each task can be very large. For example, the task to study fish populations (Table 2) is expected to yield data on species length, weight, abundance, etc. for up to 1,500 fish per quarterly sample; and the samples from the groundwater quality detection and plume characterization wells (Table 3) will be analyzed for up to 150 parameters or more.

Data on surface water quality and hydrology are collected by a variety of groups at ORNL (e.g., Environmental and Occupational Safety Division, Operations Division, Environmental Sciences Division). Summaries of such data (e.g., daily flows) as they relate to the RA Program will be incorporated into the data base to assist in calculating water budgets and contaminant loading.

Table 2. Preliminary summary of ecological characterization monitoring tasks

Task	Number of sampling sites	Number of repetitions	Sampling frequency	Example of parameters recorded
Instream monitoring				
Macro benthic invertebrates	12	3 Samples/site	Monthly	Species, abundance, weight
Fish populations	12	3 Passes	Quarterly	Species, length, weight, abundance
Fish pop. age structure	6	15 Scales/site (1–2 sp.)	Quarterly	Species, number of annuli
Fish growth rates	6	Marking up to 500 fish	Quarterly	Species, length, weight, tag No., location
Periphyton	?	?	?	Species, biomass, chlorophyll a
Aquatic contaminants				
Nonradioactive	4	8–10 Fish/site	Semiannually	PCB, Hg (others on annual basis)
Radioactive	4	8–10 Fish/site	Semiannually	^{137}Cs, ^{60}Co, ^{90}Sr
Contaminant fate and transport	?	?	?	^{137}Cs, ^{60}Co, ^{90}Sr
Terrestrial contaminants	?	?	?	Organics, radionuclides
Ambient toxicity monitoring				
Water toxicity (vertebrates)	12	4	Quarterly	% Mortality, growth rate
Water toxicity (temporal variability)	1	4	Monthly	% Mortality, growth rate
Water toxicity (invertebrates)	6	4	Quarterly	% Mortality, growth rate
Sediment toxicity	6	4	Annually	Root/shoot biomass
Biological indicators	6	8–10 Fish/site	Quarterly	Blood biochemistry, histopathology

Table 3. Preliminary summary of geohydrological characterization monitoring tasks

Task	Number of sampling sites	Sampling frequency	Example of parameters recorded
Hydrology			
Piezometer wells	300	Bimonthly initially; variable after 2 months, weather dependent	Depth to water
Hydrostatic-head measuring stations	70	Hourly	Depth to water
Groundwater quality			
Detection wells	300	Quarterly	Metals, organics, radionuclides
Plume characterization wells	120	Quarterly	Metals, organics, radionuclides

5. QUALITY ASSURANCE AND SECURITY

The subject of hazardous waste disposal is a "highly visible" regulatory topic, as evidenced by the recent amendments to the Resource Conservation and Recovery Act (RCRA) and the pending reauthorization of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Furthermore, the RA Program at ORNL involves a wide variety of remedial action sites and is being implemented by numerous personnel from several ORNL divisions. Therefore, maintaining quality assurance (QA) is an extremely important component of the RA Program. Each task leader within the RA Program is responsible for developing his own QA procedures (i.e., sampling protocols, analytical techniques, etc.). Several measures have been instituted or planned by DBM staff to ensure that the data generated by the various tasks have been accurately recorded in the data base and are protected from accidental or unauthorized access.

Data are handled as three different data sets before they become part of the RA Program data base available for interpretation: (1) raw data, (2) unverified SAS data sets, and (3) verified SAS data sets (Sect. 3.2). A formal logging procedure has been established for all incoming data. Once the data have been written as SAS data sets, either by electronic file transfer or by manual keyboarding (using double entry to greatly reduce the incidence of undetected typographical errors), the information is verified using a variety of techniques. A 100% visual inspection is performed on all printouts. Simply by looking at lists of data, it is possible to detect problems such as missing values, incorrect units of measure, etc. Other methods of data verification rely on the use of simple programming statements and plotting procedures offered by the SAS system. For example, scattergrams of the data can be plotted to identify possible outliers for further scrutiny, or range tests can be used to detect impossible or unrealistic values (e.g., a pH of 75 instead of 7.5). When appropriate, such data quality checks are done in cooperation with the staff producing the data. Staff responsible for the data are also asked to visually inspect the contents of the SAS data sets for unreasonable entries before such data become part of the verified data base.

As a further measure to control the accuracy of the data, internal audits of the data management system will be performed at random intervals throughout the project. Internal audits will conform to the Environmental Sciences Division's ongoing QA Program (Auerbach, 1981).

It is essential that the locations of all sampling sites (e.g., stream survey sites, monitoring wells) be recorded correctly. This information will be used for mapping and may be combined with results of other digitized information for analytical assessments. To this end, all existing wells to be used for remedial action characterization and assessment must be field checked to verify their coordinates on the ORNL grid.

The data management system is designed to protect the integrity of the stored data. The SAS data sets are stored on mass storage volumes on the IBM-3033 systems. Presently, the volumes are backed up with tape copies on a monthly basis. Access to the files is controlled under the AFC2 security system installed at ORNL. All data base files are maintained in a read-only status; that is, other staff ma or copy files, provided they have the proper password, but will e able to alter the files. Before the data have been made part of the verified data base, only the responsible P.I. can see the data. After the data have been incorporated into the verified data base, the P.I. and the task leader directing the work can have read-only access to the data. All other requests must first be approved by the task leader responsible for the data. This protection scheme will allow staff to perform their own data manipulations or analyses on duplicated files without jeopardizing the integrity of the original files and will reduce the likelihood of uninformed or improper interpretation of the data. The only changes allowed in the original files will be by DBM staff, and a permanent record will be kept of all such changes.

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