Prepared for the U.S. Department of Energy
Assistant Secretary for Resource Applications
Grand Junction Office, Colorado

DPST-79-138-2

# SAVANNAH RIVER LABORATORY SEMI-ANNUAL REPORT

## HYDROGEOCHEMICAL AND STREAM SEDIMENT RECONNAISSANCE

## NATIONAL URANIUM RESOURCE EVALUATION PROGRAM

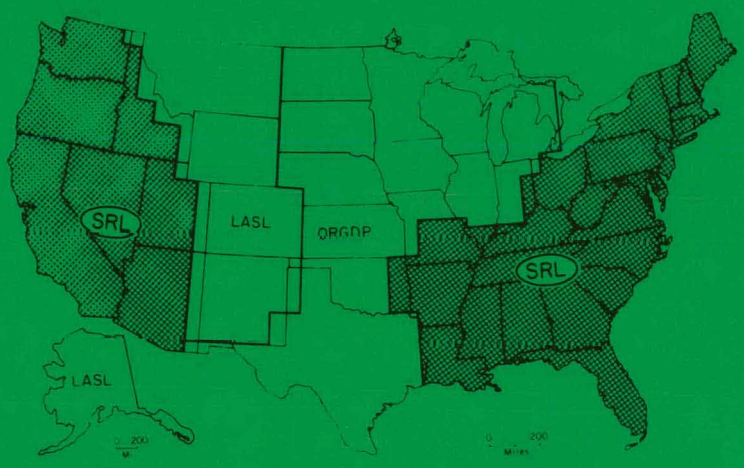
## APRIL 1979 — SEPTEMBER 1979



E. I. du Pont de Nemours & Co. (Inc.)
Savannah River Laboratory
Aiken, South Carolina 29801

PREPARED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-76SR00001

## DISCLAIMER



Prepared for the U.S. Department of Energy
Assistant Secretary for Resource Applications
Grand Junction Office, Colorado

DPST-79-138-2

# SAVANNAH RIVER LABORATORY SEMI-ANNUAL REPORT

## HYDROGEOCHEMICAL AND STREAM SEDIMENT RECONNAISSANCE

## NATIONAL URANIUM RESOURCE EVALUATION PROGRAM

## APRIL 1979 – SEPTEMBER 1979



Approved by

M. L. Hyder, Research Manager
Analytical Chemistry Division

Publication Date: October 1979

E. I. du Pont de Nemours & Co. (Inc.)
Savannah River Laboratory
Aiken, South Carolina 29801

PREPARED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-76SR00001

## ABSTRACT

This report summarizes the accomplishments, status, and program of the Savannah River Laboratory (SRL) contribution to the National Uranium Resource Evaluation (NURE) program. SRL has accepted responsibility for Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of 1,500,000 square miles in 30 eastern and 7 far-western states. The report is a progress report covering the period April 1979 through September 1979. SRL efforts in the following areas are discussed: reconnaissance and detailed studies in geological programs; management, analysis, and interpretation of analytical and field data; reporting of HSSR results; sample preparation methods; and neutron activation analysis and other analytical techniques. Appendix A to the report summarizes the SRL-NURE production of the April 1979 - September 1979 period and the program plans for the first half of FY-1980. Page-scale maps are included that show the status of completed sampling, analysis, and data reports placed on open file.

## FOREWORD

The National Uranium Resource Evaluation (NURE) program was begun in the spring of 1973 to improve the assessment of domestic uranium resources in the continental United States and to identify areas favorable for commercial exploration in response to the rapidly increasing national demand for uranium. The Grand Junction Office (DOE-GJO) of the Department of Energy (DOE) is responsible for administering and coordinating NURE program efforts. Inputs to the NURE program come from DOE prime contractors, DOE-sponsored research and development, the uranium industry, U.S. Geological Survey (USGS), U.S. Bureau of Mines (BuMines), other government agencies, and independent sources. Bendix Field Engineering Corporation (BFEC) is the prime DOE-GJO contractor for uranium resource assessment.

In 1975, the Savannah River Laboratory (SRL) accepted responsibility for hydrogeochemical and stream sediment reconnaissance (HSSR) in the eastern United States. In September 1978, SRL accepted additional responsibility for HSSR in the far west. Oak Ridge Gaseous Diffusion Plant (ORGDP) and Los Alamos Scientific Laboratory (LASL) accepted responsibility for similar reconnaissance in the rest of the continental United States including Alaska. Also in September 1978, DOE-GJO set new objectives for the program aimed at rapid completion of HSSR in 116 priority 1° x 2° NTMS quadrangles by the end of FY-1980. SRL has adjusted its plans to meet the requirements of the "116" program in both the east and the west. Details are included in the text and in Appendix A.

This progress report is one of a series summarizing accomplishments, status, and program of the SRL contribution to the NURE program. The text includes details of various program aspects and development. Appendix A summarizes status and plans for sampling, chemical analyses, and reporting.

This report is intended for managerial review and for planning purposes. The results and conclusions reported here are preliminary. Formal detailed reports on special topics will be issued when appropriate. This report is one of a series of semiannual reports to be published in April and October of each year. Published reports in this series (SRL-138) are cited in the References section.

CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

## STATUS AND PROGRAM

### HIGHLIGHTS OF THE APRIL 1979 - SEPTEMBER 1979 PERIOD

#### Geological Programs

- Reconnaissance sampling is complete or in progress for all 23 SRL western "116" priority quadrangles. A number of "A" quadrangles in both SRL's east and west assigned areas were also completed or are in progress (Appendix A).

- Specifications for sampling approximately 215,000 square miles in 31 SRL western priority "A" quadrangles were issued. Bids are in and subcontractors selected. Sampling has started in a few of these quadrangles. Because of the favorable climates in many of the quadrangles, sampling will continue fairly evenly through most of FY-1980.

- Sampling for the four SRL detailed studies in the Scranton, Ritzville, Okanogan, and Augusta quadrangles is complete.

- Four in situ training sessions were held in Tempe, Arizona, Flagstaff, Arizona, and Spokane, Washington, to train the 60 presently active sampling teams.

- Detailed subcontracted field quality assurance (QA) programs for the western reconnaissance sampling are underway. Initial checks were made by SRL-NURE personnel on all sampling subcontractors.

#### Laboratory Analyses

- The Reactor Activation Facility (RAF) was down the first five months of this reporting period because of a reactor outage. RAF production began again in early September, and approximately 10,000 samples (estimated) were analyzed (Appendix A). During the extended down-time, a number of RAF improvements and modifications were made.

- Subcontracted helium analyses of ground water samples continue at a rate of about 1000 per month. Western ground water samples are also being analyzed for helium.

- Subcontracted supplemental analyses of reconnaissance sediment samples were expanded to 22 elements (not determined by neutron activation). The supplemental data reports for several western quadrangles have been expanded to include thorium and extractable uranium so that results would be adequate to meet HSSR reporting needs where RAF analyses are not available. The rate of analyses was also temporarily stepped up from 2000 to 3000 samples per month to allow our first three western HSSR reports to be open-filed on schedule.

- Subcontracted supplemental analyses of reconnaissance water samples for 28 elements were begun by ORGDP. The maximum analysis rate is about 2000 samples per month.

- Most development work on the direct reading emission spectrometer (DRES) for DC arc analyses of sediment samples is complete. Work is continuing on some calibrations and corrections for interferences and matrix effects. An inductively coupled plasma torch for the DRES was ordered and is expected to arrive soon.

- A new and expanded QA program for RAF analyses was developed.

**Data Management, Analysis, and Interpretation**

- The NURE Data Manager Systems (NDMS) for SRL-East and SRL-West were modified to accommodate supplemental and helium analyses in addition to RAF analyses.

- The SURFACE II computer software package was successfully installed and tested on SRL's IBM 360-195 computer. The program is now available to generate contours and three-dimensional plots of spatial HSSR data.

- The interactive software package TELL-A-GRAF was also installed. A color graphics terminal for use with this and other programs is on order.

**Reporting**

- Data Reports for the Poplar Bluff, Dyersburg, Knoxville, Hartford, Atlanta, Albany, and Williamsport NTMS 1° x 2° quadrangles were transmitted to DOE-GJO for open-filing (SRL-146). Approval reports for the Death Valley and Walker Lake quadrangles are being prepared (Appendix A).

- A Data Report containing RAF analyses for the Delta-Richfield (LLL) quadrangles was sent for open-filing (Appendix A).

- A Supplemental Data Report for supplemental sediment analyses in the Athens, Charlotte, Greenville, and Spartanburg quadrangles was transmitted to DOE-GJO for open-filling.

- Other reports transmitted to DOE-GJO for open-filing were **Uraniferous Gorceixite Occurrences in Aiken County, South Carolina** and **Geology of the Birmingham, Gadsden, and Montgomery 1° x 2° NTMS Quadrangles, Alabama.**

## PROGRAM FOR THE OCTOBER 1979 - MARCH 1980 PERIOD

### Geological Programs

- Reconnaissance sampling in the remaining 30 western Priority A 1° x 2° NTMS quadrangles will be continued (Appendix A).

- Training sessions will be held at or near the sampling areas as needed to assure smooth progress in the reconnaissance sampling.

- QA checks by SRL-NURE personnel will be continued on initial work of all new sampling teams and subcontractors. The present detailed subcontracted QA work will also be continued.

- The current four SRL detailed studies in the Scranton, Augusta, Ritzville, and Okanogan quadrangles will be completed. Other DOE-GJO approved detailed study areas will be solicited, or new study areas will be proposed where indicated by anomalies in reconnaissance work.

- Specifications for reconnaissance sampling in the SRL western Priority B quadrangles will be issued.

### Laboratory Analyses

- RAF production will be maintained to meet reporting goals for reconnaissance and detailed studies. Now that priority reporting schedules are more or less fixed, RAF production will be geared to achieve a backlog of analyzed samples sufficient to meet the report schedule for the next 5 to 6 months.

- Subcontracted analyses for helium in ground waters and supplemental elements in sediments and waters will be continued. Extractable uranium will also be permanently incorporated into the supplemental analysis scheme for sediment samples.

- Evaluation and finalization of DC arc methods of analyzing sediment samples by the DRES will be completed. A plasma torch unit for the DRES will be installed to analyze water samples.

- Expanded QA on RAF analyses will be implemented.

**Data Management, Analysis, and Interpretation**

- An interactive color graphics terminal will be installed to interface with SURFACE II, TELL-A-GRAF, and other operational statistical programs.

- Modeling and statistical techniques will be developed to use and interpret large geochemical data bases effectively.

**Reporting**

- Data Reports (for open-filing) and data tapes will be completed for seventeen 1° x 2° NTMS western "116" priority quadrangles.

## GEOLOGICAL PROGRAMS

### RECONNAISSANCE

#### "116" Quadrangles

Contracts were issued for the sampling of all 23 highest (116) priority quadrangles in SRL's seven western states. Sampling of all 23 will be complete before November 30, 1979. Ground water sites were not as numerous as was anticipated. To compensate for the scarcity of ground water sites, subcontractors were asked to increase the density at which surface samples were taken. By September 30, about 30,000 surface sites and about 10,000 ground water sites were sampled.

SRL Staff trained about 60 sampling teams at four training sessions held in Tempe and Flagstaff, Arizona, and in Spokane, Washington. Several changes were made to SRL's sampling methods to accommodate the arid environment of most of the areas sampled in 1979. Several of the changes are:

- Addition of scintillometer readings to site data.
- Elimination of several description characteristics for the western sites. Samplers now take photographs of sampling sites.
- A 60-mL sample of water (preserved with high-purity nitric acid) is to be collected from every ground water and stream water site.
- In some desert areas, two sediment fractions are taken: 18 to 40 mesh and minus 40 mesh.
- Collection of water samples for He/Ne analyses at all ground water sites.
- Topographic maps are to be used in place of county maps.
- Supplemental samples may be taken at geologically odd sites such as geothermal springs or volcanic necks.

A new field manual (Price and Jones, 1979) that incorporates these changes was issued to samplers.

Obtaining uniform areal sample coverage of western quadrangles has been much more difficult than in the east, and in some cases has been impossible. Besides the ruling by the Department of the Interior that all National Park Lands would be off-limits for sampling, permission to sample some Indian and military lands also could not be obtained. Many high or mountainous areas received their heaviest snows in twenty years. The snow in many of these areas never melted during the summer. Sampling by foot or vehicle was impossible, and although helicopters were used as a last resort, the sampling season was too short to allow complete coverage. Because of the urgency of the "116" quadrangle reporting schedule, SRL's normal practice of follow-up sampling at a later time will not be possible.

### "A" Quadrangles

Small amounts of sampling continued in Eastern "A" quadrangles. Surface samples were taken in Evansville, Winchester, Jenkins, Ogdensburg, and Utica quadrangles. Groundwater samples were taken in the Jenkins, Ogdensburg, and Utica quadrangles. All other Eastern "A" quadrangles are completely sampled.

Bids were received for the sampling of 31 "A" quadrangles in the western states. Of these, sampling is complete in the Vya quadrangle, and is in progress in the San Luis Obispo and Baker quadrangles.

Because of the favorable climates in many of the western "A" quadrangles, sampling should proceed evenly throughout most of FY-1980. SRL hopes to complete sampling of all its western "A" quadrangles by FY-1980. However, if problems similar to those discussed above are encountered, appropriate sampling will be deferred to FY-1981 to ensure complete areal coverage.

## DETAILED STUDIES

Plans for detailed studies in four areas were discussed in the October 1978 - March 1979 semiannual report (SRL-138-15). The Midnite Mine study was enlarged to include uranium occurrences at nearby Mount Spokane. Sampling in all detailed study areas is completed; analyses and reporting are scheduled to be completed by September 1980.

Botanical sampling was added to the scope of projects in the Midnite Mine - Mount Spokane and Kettle Falls Dome, Washington, and the Glen Wild, New York, areas. U. S. Geological Survey studies (Nash and Ward, 1977) indicate that the uranium content of needles of native Ponderosa Pine trees can be related to uranium

deposits in the Midnite Mine area. Preliminary SRL studies in the Mount Spokane area indicate an anomaly-to-background contrast of better than 10:1 for the uranium content of needles and twigs of the Grand Fir conifers.

**Midnite Mine - Mount Spokane Study and the Kettle Falls Study**

Sampling was completed in these areas in September 1979. Some geophysical data are available for the Midnite Mine area and may be incorporated into the study.

**Aiken County Study**

This study was discussed previously (SRL-138-15) both as an orientation study and as a detailed study. The adjusted scope of the combined projects is as follows:

1. Stream and well sampling have been completed over an area of about 1200 square miles at a nominal density of one site per square mile.

2. Geologic mapping of Aiken County was completed under a contract to the South Carolina Geological Survey.

3. Limited drilling has been conducted to support geologic mapping.

**Glen Wild, New York Area**

All planned sampling has been completed. This study included 4-channel gamma spectrometer determinations for total gamma activity, potassium, uranium, and thorium.

## LABORATORY ANALYSES

### SAMPLE PREPARATION

Production for the second half of FY-1979 is summarized in Appendix A. Approximately 65,000 prepared samples are back-logged for activation in the RAF. Preparation of both water (resin) and sediment samples continued on schedule this period. Current production rates are adequate to meet analysis and reporting schedules and will continue.

During the second half of FY-1979, approximately 15,000 sediment samples, 6,000 surface water samples, and 20,000 ground water samples were prepared. In addition, approximately 7000 sediment samples, previously collected by Lawrence Livermore Laboratory, were prepared for analysis.

### NEUTRON ACTIVATION ANALYSIS

#### Reactor Activation Facility

A number of modifications and improvements were made to the Reactor Activation Facility (RAF) during the long reactor shutdown. These changes eliminate many of the minor operating difficulties previously encountered, and greatly reduce the potential for a catastrophic data loss in the event of a disk failure.

A major modification to the RAF is the incorporation of the automatic sample unloading station installed in 1978 (SRL-138-13). Extensive software reprogramming was made to control the unloader. The unloader system, capable of storing approximately 10,000 samples, significantly reduces personnel radiation exposure and speeds unloading procedures. The previous manual unloading (2 to 3 times per week) of the stacks required several hours in close proximity to thousands of irradiated samples. With the automatic unloader, samples need to be emptied only once every week or two, and requires less than 30 minutes.

The RAF was also modified to allow dual-disk operation. All vital process control and data information can now be written to both disks simultaneously. Previous RAF operation used only a single disk, and a disk failure could have resulted in the loss of data for several thousand samples. Now failure of either disk will shut down the system, but vital information required to restart the

system is available on the other disk. Single-disk operation is still possible if a failed disk should require extensive repair, thus a minimum of production time would be lost.

The final installation and check of the motor generator was completed this period. This power supply for computer operation allows about 20 seconds of additional operating time in the event of power failure. Also a smoother, more reliable, power source for computer and detector operations is obtained from the generator. These features will further enhance the reliability of the RAF.

Other changes were made in the pneumatic system to eliminate some of the more frequent minor operating difficulties.

- Small orifice-pilot-activated valves, which tended to stick after long periods of heavy use, were replaced with solenoid activated valves.
- Other pneumatic valves in service were cleaned and checked to ensure good performance.
- All photocells in areas of high radiation exposures were replaced to assure against failure after start-up.
- All 4-way diverters were cleaned and repaired for reliable operation. The last two old-style 4-way diverters (retained from the pilot facility) were replaced with new, more-reliable, 4-way diverters of SRL design.
- The RAF's pneumatic air exhaust system was split and expanded to prevent pressurization which had resulted in sporadic rabbit transport problems.
- All parts of the pneumatic systems and stacks were inspected and cleaned as a preventive maintenance procedure.

RAF production resumed in early September. An estimated 10,000 western reconnaissance samples were analyzed through September 30, 1979.

## OTHER ANALYTICAL TECHNIQUES

The Jarrell-Ash Model 750 direct-reading emission spectrometer (DRES) is now operational. The spectrometer includes dual floppy disks, card reader, and a DEC 8E computer with 8K of memory. The spectrometer is capable of measuring the concentrations of twenty-seven elements in stream sediment samples. Samples are excited in a direct-current arc stand using an automatic sample changer purchased from Oak Ridge National Laboratory.

The instrumentation was calibrated with United States Geological Survey (USGS) analyzed samples and with several international reference samples. While no "certified" standards are available for sediment analyses, the USGS and the international reference samples are quoted in "recommended" or "usable" values. A list of DRES profiled constituents and concentration ranges in sediment samples is shown in Table 1.

Final calibration and method checkout will be made by analyzing fifty USGS sediment samples on the DRES and comparing the results with USGS analysis values. Preliminary results of a USGS reference sample (analyzed as unknown) and two USGS stream sediments (from Maine) are shown in Table 2. The excellent agreement of results is encouraging; full documentation will be reported elsewhere once all results are available. Receipt of an inductively coupled plasma torch unit is expected in the first quarter of FY-1980. The plasma torch will be attached to the DRES and evaluated for analyses of NURE ground water samples.

The DRES with arc and plasma torch excitation will be used primarily for quality assurance checks on RAF and subcontracted sediment and water analyses.

**SUPPLEMENTAL ANALYSES**

Supplemental analyses of sediment samples have been expanded to include As, Se, and Ca; bringing to 22 the number of elements measured by methods other than NAA. Because of the extended reactor shutdown, the elements uranium and thorium were temporarily added to the list of supplemental analyses, and the subcontractor performing the supplemental analyses increased his production rate from 2000 to 3000 samples per month. As a result, the reports on Mesa, Salton Sea, and Okanogan (LLL) which could not be met with NAA data, will be reported instead using supplemental analyses data.

Uranium concentrations are being determined by laser-excited fluorescence of acid-leach solutions of the sediment samples. Thus, values reported will be for extractable uranium, U(ex). Because strong acid interferes with the laser technique, leach solutions are diluted with water by about 1000 fold. Dilution also brings the uranium concentration down into the useful range of the laser instrument (1 to 20 ppb). Thorium is being determined by x-ray fluorescence of the ground sediment sample; the detection limit is about 20 ppm.

Helium-neon analyses are being done on the western ground water samples. Most samples are analyzed within three weeks from the time they arrive at SRL. Some of these samples are also being analyzed for methane, which would indicate the possible presence of reducing hydrocarbons.

**TABLE 1**

**Calibration Ranges of Stream Sediment Constituents**

| Constituent | Concentration Range, % |
|---|---|
| $Al_2O_3$ | 6 - 17.5 |
| CaO | 0.7 - 8 |
| $TiO_2$ | 0.4 - 2.2 |
| $Na_2O$ | 1.1 - 6.2 |
| $K_2O$ | 0.6 - 12.8 |
| MgO | 0.5 - 22.9 |
| $Fe_2O_3$ | 1.4 - 13.5 |
| $P_2O_5$ | 0.02 - 0.5 |
| $SiO_2$ | 50 - 90 |

| Constituent | Concentration Range, ppm |
|---|---|
| Ag | 1 - 20 |
| B | 2.5 - 40 |
| Ba | 5 - 1800 |
| Be | 0.5 - 50 |
| Co | 5 - 47 |
| Cr | 10 - 100 |
| Cu | 3 - 60 |
| Li | 2 - 100 |
| Mo | 5 - 100 |
| Ni | 6 - 464 |
| Pb | 5 - 240 |
| Sn | 5 - 100 |
| V | 10 - 464 |
| Y | 7 - 130 |
| Zr | 10 - 1000 |
| La, Mn, Nb | Lines not profiled |

TABLE 2

Comparison of Analytical Values of Reference Samples

| | Sample: | BCR-1* | | DR-N** | | 40/60*** | | 41/98*** | |
|---|---|---|---|---|---|---|---|---|---|
| | Constituent | Accepted Value | Analyzed Value | Accepted Value | Analyzed Value | USGS Value | Analyzed Value | USGS Value | Analyzed Value |
| wt % | $SiO_2$ | 54.85 | 53.71 | 52.88 | 53.69 | - | - | - | - |
| | $Al_2O_3$ | 13.68 | 14.82 | 17.56 | 17.73 | 10 | 11.0 | 13.2 | 10.4 |
| | CaO | 6.98 | 6.58 | 7.09 | 7.31 | 2.80 | 1.70 | 1.40 | 1.76 |
| | MgO | 3.49 | 4.39 | 4.47 | 6.15 | 1.15 | 0.94 | 1.66 | 2.43 |
| | $TiO_2$ | 2.22 | 2.31 | 1.10 | 1.16 | 0.25 | 0.34 | 0.50 | 1.03 |
| | $Na_2O$ | 3.29 | 2.39 | 3.00 | 2.43 | 4.05 | 3.91 | 1.35 | 1.93 |
| | $Fe_2O_3$ | 13.54 | 13.60 | 9.69 | 9.78 | 2.86 | 2.65 | 4.3 | 6.53 |
| | $P_2O_5$ | 0.33 | 0.32 | 0.25 | 0.19 | - | - | - | - |
| | $K_2O$ | 1.68 | 1.61 | 1.73 | 1.35 | 3.61 | 3.71 | 2.41 | 2.40 |
| ppm | Ag | 5 | 1 | - | 1 | - | - | - | 1 |
| | B | 5 | 5 | - | 8 | <20 | 13 | <20 | 32 |
| | Ba | 680 | 562 | 380 | 329 | 700 | 474 | 500 | 434 |
| | Be | 1.7 | 2 | - | 2 | 2 | 1 | 2 | 2 |
| | Co | 37 | 32 | 35 | 31 | 7 | 6 | 20 | 35 |
| | Cr | 16 | 15 | 45 | 34 | 70 | 78 | 100 | 111 |
| | Cu | 19 | 19 | 52 | 33 | 2 | 7 | 50 | 43 |
| | Li | 13 | 14 | 45 | 35 | - | 45 | | 55 |
| | Mo | 3? | 37 | - | 27 | 5 | 3 | 5 | 10 |
| | Ni | 13 | 17 | 22 | 22 | 10 | 45 | 50 | 117 |
| | Pb | 15 | 16 | 65 | 37 | 20 | 21 | 20 | 24 |
| | Sn | 4 | 6 | - | 4 | - | 3 | - | 3 |
| | V | 410 | 311 | 220 | 241 | 30 | 40 | 100 | 76 |
| | Y | 37 | 34 | 32? | 28 | 15 | 7 | 30 | 38 |
| | Zr | 185 | 173 | 125? | 191 | 70 | 81 | 200 | 283 |

* USGS basalt reference sample.
** France diorite reference sample.
*** USGS stream sediment and samples from Maine.
\- Not determined.
? No accepted value has been established.

Acidified water samples are being analyzed by Oak Ridge Gaseous Diffusion Plant (ORGDP). Production rates are about 400 samples per week. Elements analyzed and their detection limits are listed in Table 3.

**TABLE 3**

**Elements and Detection Limits in Acidified Water Samples**

| Elements | Detection Limit, ppb |
|---|---|
| Ag | 2 |
| Al | 10 |
| As | 0.5 |
| B | 8 |
| Ba | 2 |
| Be | 1 |
| Ca | 100 |
| Co | 2 |
| Cr | 4 |
| Cu | 2 |
| Fe | 10 |
| K | 100 |
| Li | 4 |
| Mg | 100 |
| Mn | 2 |
| Mo | 4 |
| Na | 100 |
| Ni | 4 |
| P | 40 |
| Sc | 1 |
| Se | 0.2 |
| Si | 100 |
| Sr | 5 |
| Ti | 2 |
| V | 4 |
| Y | 1 |
| Zn | 4 |
| Zr | 2 |

## QUALITY ASSURANCE

### Field Quality Assurance Programs

Quality assurance (QA) programs for western field work continue to parallel those developed for the east. All subcontractors and their samplers were checked by SRL personnel at least once. Only a few minor problems were encountered. In each case the problems were explained to the subcontractor, and the subcontractor was required to have sub-standard personnel retrained, or to provide documentation to affirm the problems were corrected. In most cases follow-up QA by SRL personnel was done to ensure compliance. Separate QA checks by a qualified subcontractor (not active in any present or planned future sampling) are in progress. Approximately 6 to 10% of all sites sampled will be checked.

### RAF Quality Assurance Programs

A new and much improved QA program for RAF analytical data has been implemented. RAF production has increased to the point that only computerized techniques are capable of fully evaluating the data generated from the thousands of standard and blank samples.

A blank and a standard occur every 24th and 25th sample in the analyses of sediments. Data from the thousands of SRL standards analyzed by the RAF from September 1978 through April 1979 have been reduced into convenient computerized data sets which will serve as a basis for future RAF QA. Statistical evaluation of analyses for uranium and other elements determined in the four SRL sediment standards are shown in Tables 4 through 7. Accepted values represent a compilation of results of emission spectrometry, NAA, and other techniques obtained from other laboratories.

RAF data reduction programs have been modified to allow more effective use of standard and blank sample information. Real-time printout of blank and standard analyses will continue as a first-hand check by the RAF operator for potential problems. But in addition, analyses will also be tagged by date and the identification number of the detector(s) involved. These data will also be split for incorporation into, and/or comparison with, the data sets shown in Tables 4 through 7. Any erroneous results for blanks or standards will be apparent and traced back by time and detector to their source. All potentially affected samples will be flagged and reanalyzed.

A new uranium/multielement resin standard has also been prepared. All future resin sample groupings will conform to the blank and standard sequence used for sediment samples.

New QA data for sediments and resins (when available) will be included in future Data Reports.

TABLE 4

**Statistical Summary of Analytical Results for SRL 2.1 Sediment Standard**

| Element | Number | Mean, ppm | Coefficient of Variation, % | Accepted Value, ppm |
|---|---|---|---|---|
| U | 263 | 7.24 | 5.0 | |
| Th | 236 | 27.8 | 15.3 | |
| Hf | 254 | 45.7 | 13.4 | |
| Al | 249 | 15,400 | 10.3 | |
| Ce | 234 | 133 | 15.7 | |
| Fe | 232 | 7300 | 34.2 | |
| Mn | 234 | 117 | 16.9 | |
| Sc | 247 | 2.77 | 26.6 | Not |
| Na | 239 | 200 | 18.2 | Available |
| Ti | 233 | 6220 | 14.7 | |
| V | 245 | 27.0 | 15.6 | |
| Dy | 233 | 8.9 | 25.7 | |
| Eu | 54 | 2.35 | 48.7 | |
| La | 247 | 72.2 | 30.5 | |
| Lu | 243 | 0.88 | 30.6 | |
| Sm | 245 | 13.5 | 31.6 | |
| Yb | 216 | 5.83 | 39.0 | |

TABLE 5

**Statistical Summary of Analytical Results for SRL 2.2 Sediment Standard**

| Element | Number | Mean, ppm | Coefficient of Variation, % | Accepted Value, ppm |
|---|---|---|---|---|
| U | 294 | 21.8 | 5.8 | 22.2 |
| Th | 295 | 114 | 15.2 | 125 |
| Hf | 296 | 146 | 18.1 | 173 |
| Al | 289 | 7000 | 10.8 | 6500 |
| Ce | 288 | 534 | 15.5 | 614 |
| Fe | 273 | 6600 | 26.2 | 6700 |
| Mn | 266 | 275 | 15.8 | 300 |
| Sc | 297 | 3.41 | 26.8 | 3.9 |
| Na | 278 | 150 | 36.3 | 145 |
| Ti | 271 | 12,400 | 20.6 | 13,200 |
| V | 282 | 33.7 | 16.9 | 34.7 |
| Dy | 275 | 27.3 | 38.0 | <22 |
| Eu | 175 | 2.74 | 35.4 | 2.5 |
| La | 276 | 279 | 17.5 | 301 |
| Lu | 253 | 2.55 | 13.2 | 2.9 |
| Sm | 280 | 47.7 | 38.2 | 51.3 |
| Yb | 294 | 15.9 | 21.3 | 18.2 |

TABLE 6

**Statistical Summary of Analytical Results for SRL 3.1 Sediment Standard**

| Element | Number | Mean, ppm | Coefficient of Variation, % | Accepted Value, ppm |
|---|---|---|---|---|
| U | 162 | 42.0 | 5.0 | 41.3 |
| Th | 163 | 166 | 15.5 | 162 |
| Hf | 25 | 2 | 104.8 | 7.4 |
| Al | 132 | 37,000 | 16.6 | 30,600 |
| Ce | 149 | 913 | 17.5 | 903 |
| Fe | 160 | 16,000 | 19.3 | 15,200 |
| Mn | 156 | 283 | 16.4 | 289 |
| Sc | 169 | 4.55 | 36.7 | 4.19 |
| Na | 167 | 1030 | 30.6 | 901 |
| Ti | 114 | 5870 | 15.9 | 6100 |
| V | 147 | 50.6 | 17.0 | 54.4 |
| Dy | 135 | 71.2 | 20.9 | 50* |
| Eu | 151 | 3.90 | 29.3 | 3.86 |
| La | 153 | 470 | 16.4 | 443 |
| Lu | 152 | 4.78 | 17.3 | 4.4 |
| Sm | 159 | 68.8 | 36.6 | 69.2 |
| Yb | 161 | 33.1 | 18.6 | 29.9 |

* Only one laboratory reported dysprosium value.

TABLE 7

**Statistical Summary of Analytical Results for SRL 4.1 Sediment Standard**

| Element | Number | Mean, ppm | Coefficient of Variation, % | Accepted Value, ppm |
|---|---|---|---|---|
| U | 159 | 0.56 | 11.8 | 0.58 |
| Th | 93 | 2.4 | 42.3 | 2.1 |
| Hf | 122 | 3.2 | 46.4 | 4.4 |
| Al | 112 | 71,000 | 15.7 | 66,700 |
| Ce | 105 | 59 | 22.8 | 44 |
| Fe | 156 | 85,500 | 14.6 | 87,300 |
| Mn | 141 | 1850 | 16.8 | 1970 |
| Sc | 158 | 20 | 34.4 | 21 |
| Na | 153 | 18,800 | 15.6 | 16,100 |
| Ti | 91 | 26,700 | 14.6 | 25,200 |
| V | 136 | 259 | 16.1 | 273 |
| Dy | 16 | 7.3 | 29.2 | <22 |
| Eu | 79 | 1.47 | 37.2 | 1.16 |
| La | 157 | 18.2 | 18.1 | 18.6 |
| Lu | 129 | 0.22 | 31.4 | 0.28 |
| Sm | 152 | 3.4 | 24.6 | 4.2 |
| Yb | 60 | 2.1 | 47.8 | 1.6 |

## DATA MANAGEMENT, ANALYSIS, AND INTERPRETATION

The NURE Data Manager Systems (NDMS) for SRL-East and SRL-West were modified to accommodate supplemental elemental analyses and He/Ne ratios in addition to data from the RAF.

The software library at SRL has been expanded. SURFACE II, a graphics software package, has been successfully installed and tested at SRL. SURFACE II is capable of transforming data and producing planar (contours and/or postings) and 3-dimensional plots of the data. Both the 2- and 3-dimensional capabilities have been used to interpret reconnaissance data from two northeastern and six southeastern quadrangles. Also, TELL-A-GRAF, an interactive software package, has been installed at SRL. This package allows users to concoct complex plots of data with simple commands given in the English language.

Hardware at SRL also is in the process of being upgraded. A project has been submitted to purchase and install a color graphics terminal and peripheral equipment. The terminal will be used to interpret NURE data in conjunction with several software packages at SRL.

## REPORTING HSSR RESULTS

During the April - September 1979 period, Data Reports covering the Poplar Bluff, Dyersburg, Knoxville, Hartford, Atlanta, Albany, and Williamsport quadrangles were completed and transmitted to DOE-GJO for open filing (SRL-146). A Data Report containing RAF analyses for the LLL samples collected in Delta and Richfield quadrangles was also sent to DOE-GJO for open-filing.

A Supplemental Data Report for sediment analyses in the Athens, Charlotte, Greenville, and Spartanburg quadrangles was transmitted to DOE-GJO for open-filing. Other reports sent to DOE-GJO were: **Uraniferous Gorceixite Occurrences in Aiken County, South Carolina** (Ferguson, et al., 1979), and **Geology of the Birmingham, Gadsden, and Montgomery 1° x 2° NTMS Quadrangles, Alabama** (Copeland and Beg, 1979).

To meet the schedule of the Bendix Field Engineering Corporation for reporting quadrangle reconnaissance data, tapes containing analyses of more than 20 supplementary elements plus thorium and extractable uranium values for the Mesa, Salton Sea, and Okanogan (LLL) quadrangles were transmitted to DOE-GJO for open-filing. Data Reports containing RAF data for the Mesa and Salton Sea quadrangles will be issued during the second half of FY-1980.

Data Reports containing hard-copy RAF data have been simplified. All histograms and cumulative frequency plots will now appear on microfiche only. This modification will significantly decrease the time needed for compilation and printing of each Data Report.

The forecasted reporting schedule for the first half of FY-1980 is summarized in Appendix A, Table A-3.

## REFERENCES


Copeland, C. W., and Beg, M. A., 1979, **Geology of the Birmingham, Gadsden, and Montgomery 1° x 2° NTMS quadrangles, Alabama:** USDOE Report DP-1530, E. I Du Pont de Nemours & Company, Savannah River Laboratory, Aiken, South Carolina.

Ferguson, R. B., Price, V., Jr., and Mosley, W. C., Jr., 1979, **Uraniferous Gorceixite Occurrences in Aiken County, South Carolina:** SRL Document DPST-79-318, E. I. Du Pont de Nemours & Company, Savannah River Laboratory, Aiken, South Carolina.

Nash, J. T., and Ward, F. N., 1977, **Biogeochemical Prospecting for Uranium with Conifers - Results from the Midnite Mine Area, Washington:** USGS Report OFR 77-354, p. 23.

Price, V., Jr., and Jones, P. L., 1979, **Training Manual for Water and Sediment Geochemical Reconnaissance:** SRL Document DPST-79-219, E. I. Du Pont de Nemours & Company, Savannah River Laboratory, Aiken, South Carolina.

SRL-138, **Savannah River Laboratory Quarterly and Semiannual Reports, Hydrogeochemical and Stream Sediment Reconnaissance, National Uranium Resource Evaluation Program:** E. I. Du Pont de Nemours & Company, Savannah River Laboratory, Aiken, South Carolina.

| No. | Period | SRL Doc. No. | DOE-GJO Doc. No.* |
|---|---|---|---|
| 1 | January-March 1975 | DPST-75-138-1 | GJBX-5(76) |
| 2 | April-June 1975 | DPST-75-138-2 | GJBX-6(76) |
| 3 | July-September 1975 | DPST-75-138-3 | GJBX-7(76) |
| 4 | October-December 1975 | DPST-75-138-4 | GJBX-8(76) |
| 5 | January-March 1976 | DPST-76-138-1 | GJBX-17(76) |
| 6 | April-June 1976 | DPST-76-138-2 | GJBX-27(76) |
| 7 | July-September 1976 | DPST-76-138-3 | GJBX-63(76) |
| 8 | October-December 1976 | DPST-76-138-4 | GJBX-6(77) |
| 9 | January-March 1977 | DPST-77-138-1 | GJBX-35(77) |
| 10 | April-June 1977 | DPST-77-138-2 | GJBX-55(77) |
| 11 | July-September 1977 | DPST-77-138-3 | GJBX-90(77) |
| 12 | October-December 1977 | DPST-77-138-4 | GJBX-37(78) |
| 13 | January-March 1978 | DPST-78-138-1 | GJBX-66(78) |
| 14 | April-September 1978 | DPST-78-138-2 | GJBX-13(79) |
| 15 | October 1978 - March 1979 | DPST-79-138-1 | GJBX-86(79) |
| 16 | April-September 1979 | DPST-79-138-2 | (this report) |

SRL-146, **SRL-NURE Data Reports**, E. I. du Pont de Nemours & Co., Inc. Savannah River Laboratory, Aiken, South Carolina.

| No. | NTMS 1° x 2° Quadrangle | SRL Doc. No. | DOE-GJO Doc. No.* |
|---|---|---|---|
| 1 | Winston-Salem† | DPST-77-146-1 | GJBX-66(77) |
| 2 | Spartanburg | DPST-77-146-2 | GJBX-09(78) |
| 3 | Charlotte | DPST-78-146-1 | GJBX-40(78) |
| 4 | Greenville | DPST-78-146-2 | GJBX-47(78) |
| 5 | Winston-Salem†† | DPST-78-146-3 | GJBX-58(78) |
| 6 | Greensboro | DPST-78-146-4 | GJBX-74(78) |
| 7 | Knoxville | DPST-78-146-5 | GJBX-75(79) |
| 8 | Scranton | DPST-78-146-6 | GJBX-02(79) |
| 9 | Athens | DPST-78-146-7 | GJBX-20(79) |
| 10 | Harrisburg | DPST-79-146-1 | GJBX-31(79) |
| 11 | Portland | DPST-79-146-2 | GJBX-28(79) |
| 12 | Glens Falls | DPST-79-146-3 | GJBX-44(79) |
| 13 | Augusta | DPST-79-146-4 | GJBX-45(79) |
| 14 | Dyersburg | DPST-79-146-5 | GJBX-58(79) |
| 15 | Poplar Bluff | DPST-79-146-6 | GJBX-63(79) |
| 16 | Hartford | DPST-79-146-7 | GJBX-94(79) |
| 17 | Williamsport | DPST-79-146-8 | (in process) |
| 18 | Newark | DPST-79-146-9 | (in process) |
| 19 | Albany | DPST-79-146-10 | GJBX-140(79) |
| 20 | Atlanta | DPST-79-146-11 | GJBX-129(79) |
| 21 | Delta, Richfield | DPST-79-146-12 | (in process) |

† Sediment only. †† Ground water only.

* DOE-GJO reports are available on microfiche from the Grand Junction Office, DOE, for $6.00. Prepaid orders should be sent to: Bendix Field Engineering Corporation, Technical Library, P.O. Box 1569, Grand Junction, CO 81501. Checks or money orders should be made out to Bendix Field Engineering Corporation, the operations contractor for DOE's Grand Junction Office.

## APPENDIX A: SRL-NURE Production Report and Program Plans for the April 1979 - March 1980 Period

### SUMMARY

This Appendix provides a summary of SRL-NURE production for the past six months, and program plans for the next six months. Information is presented in tables and figures to serve as a quick overview of text discussions on sample collection, preparation, analyses, and reporting.

### PRODUCTION FOR SECOND HALF OF FY-1979 AND PROGRAM PLANS FOR FIRST HALF OF FY-1980

Production statistics for samples collected, prepared, and analyzed are summarized in Table A-1. Similar statistics forecasted for the first half of FY-1980 are shown in Table A-2. Areal plots showing completed and planned work in sampling, NAA, and reporting for the SRL East and SRL West are Figures A-1 through A-6. Details of planned Data Reports for the first half of FY-1980 are given in Table A-3.

### LIST OF FIGURES

## LIST OF TABLES



**TABLE A-1**

**SRL-NURE Production Statistics***

| | Western States | | Eastern States | |
|---|---|---|---|---|
| | 2nd Half 1979 | Total to Date | 2nd Half 1979 | Total to Date |
| A. Samples Collected: (In Thousands) | | | | |
| Ground Water | 8 | 8 | 4 | 74 |
| Sediment | 30 | 30 | 4 | 68 |
| Surface Water | 4 | 4 | 3 | 33 |
| Total | 42 | 42 | 9 | 175 |
| B. Samples Prepared: (In Thousands) | | | | |
| Ground Water | 4 | 4 | 18 | 64 |
| Sediment | 10 | 10 | 12 | 57 |
| Surface Water | 2 | 2 | 10 | 31 |
| Total | 16 | 16 | 40 | 152 |
| C. Samples Analyzed: (In Thousands) | | | | |
| Sediment | 2 | 2 | - | 31 |
| Resin | - | - | 2 | 41 |
| Supplementary (Sediment) | 5 | 5 | 8 | 12 |
| Supplementary (Water) | 4 | 4 | - | - |
| Total | 11 | 11 | 10 | 84 |

* Reconnaissance samples only.

**TABLE A-2**

**Forecasted Sampling and Analytical Statistics for October 1979 - March 1980**

A. Sample Collection (In Thousands)

| Sample Type: | |
|---|---|
| Ground Water | 7 |
| Stream Water | 3 |
| Stream Sediment | 10 |
| Total | 20 |

B. Sample Preparation (In Thousands)

| Sample Type: | |
|---|---|
| Sediment | 25 |
| Resin | 15 |
| Total | 40 |

C. Sample Analysis (In Thousands)

| Analysis Method: | |
|---|---|
| Neutron Activation | 60 |
| Supplemental (Sediment) | 15 |
| Supplemental (Water) | 12 |
| Helium/Neon | 7 |
| Total | 94 |

TABLE A-3

Reporting Plan (Data Reports) for October 1979 - March 1980

| Quadrangle | Date Due to DOE-GJO |
|---|---|
| Death Valley | 10/79 |
| Walker Lake | 10/79 |
| McDermitt (LLL) | 11/79 |
| Wells (LLL) | 11/79 |
| Reno | 11/79 |
| Flagstaff | 11/79 |
| Marble Canyon | 12/79 |
| Grand Canyon | 12/79 |
| Pocatello | 12/79 |
| Challis | 1/80 |
| Ritzville | 1/80 |
| Elko | 1/80 |
| Price | 2/80 |
| Salina | 2/80 |
| Trona | 3/80 |
| Klamath Falls | 3/80 |
| Escalante | 3/80 |

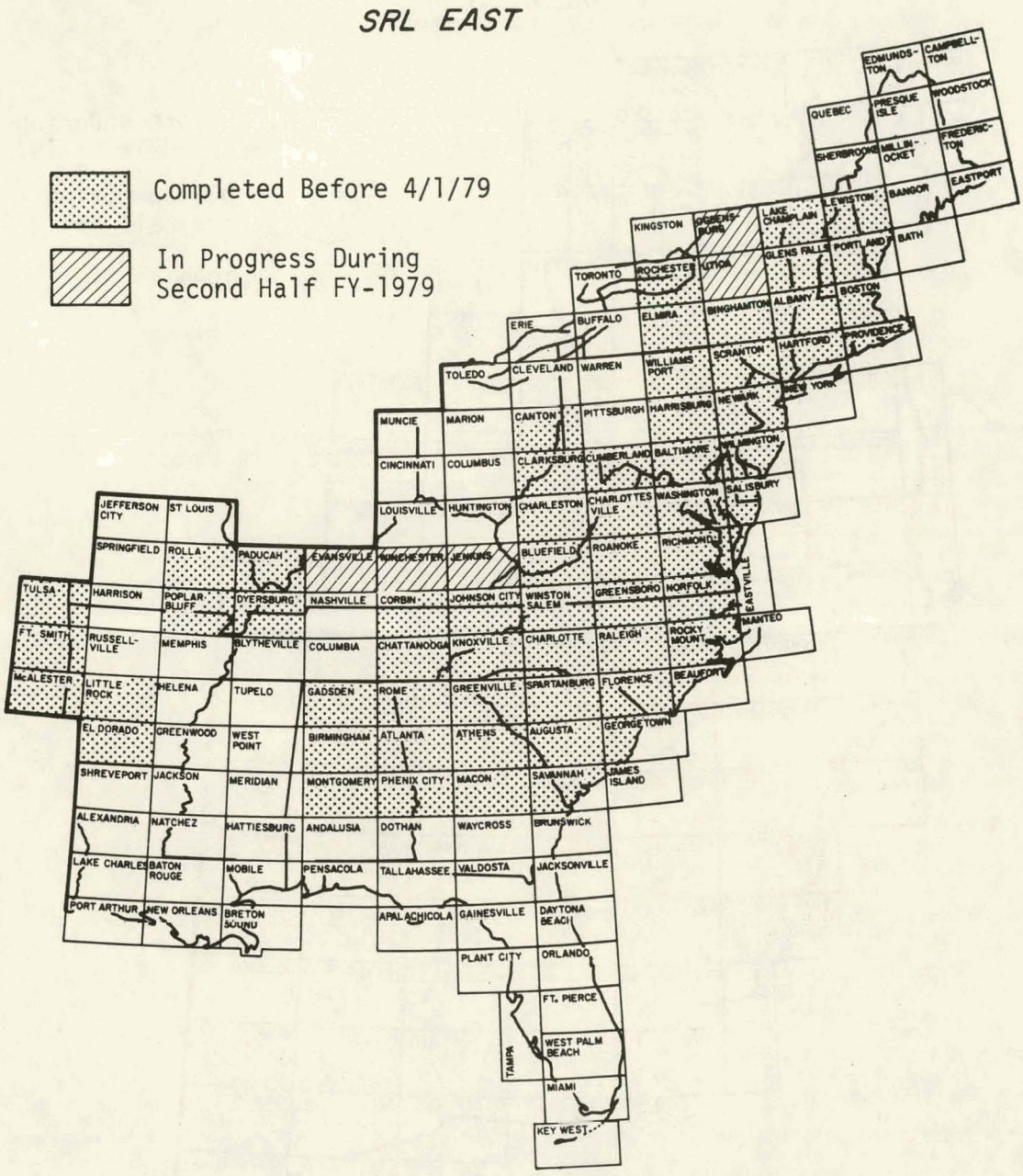
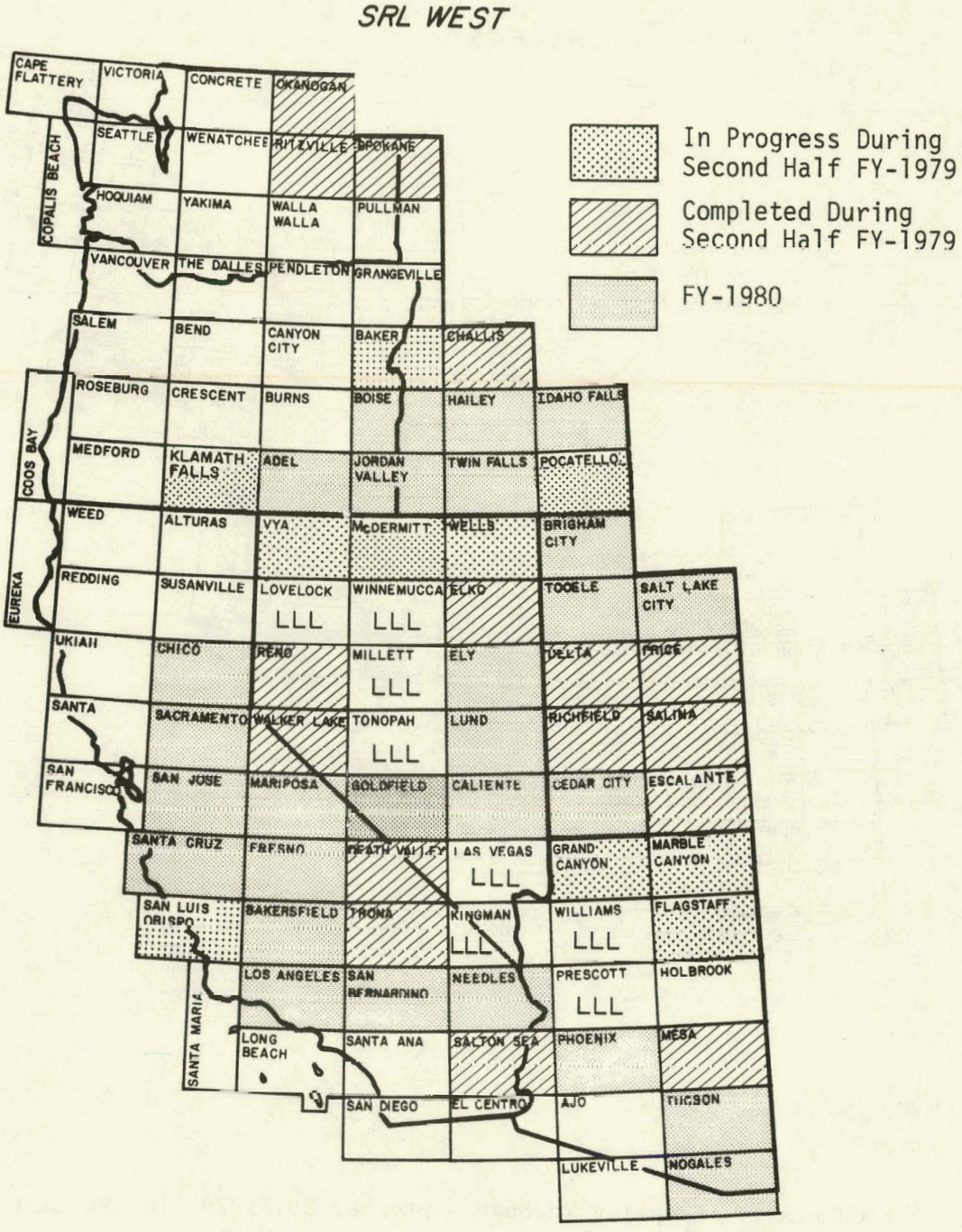



**FIGURE A-1. Sampling Through September 30, 1979, in SRL East**




Note: Quadrangles marked LLL were sampled and reported previously by Lawrence Livermore Laboratory.

**FIGURE A-2. Sampling Through September 30, 1979, in SRL West**

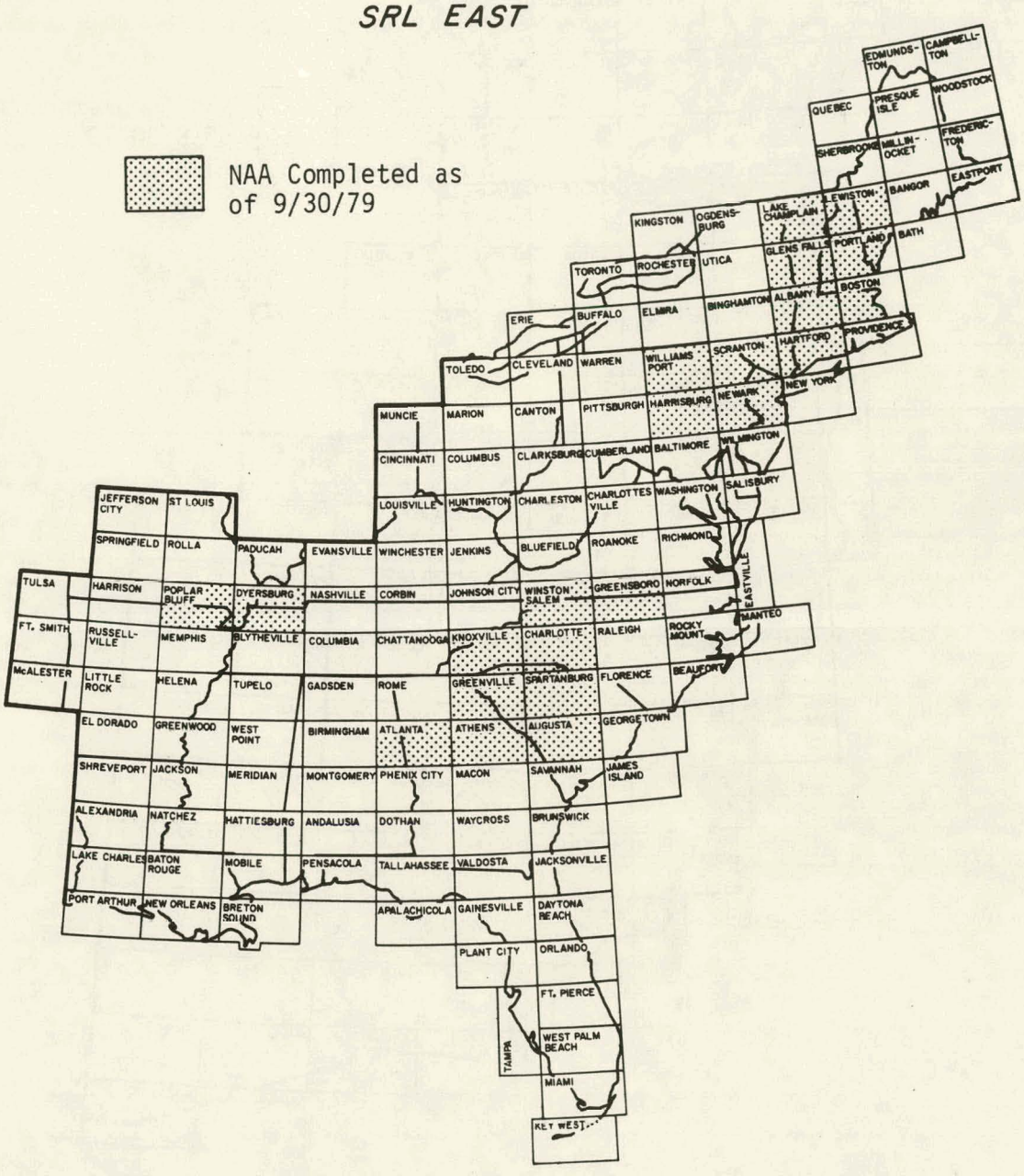
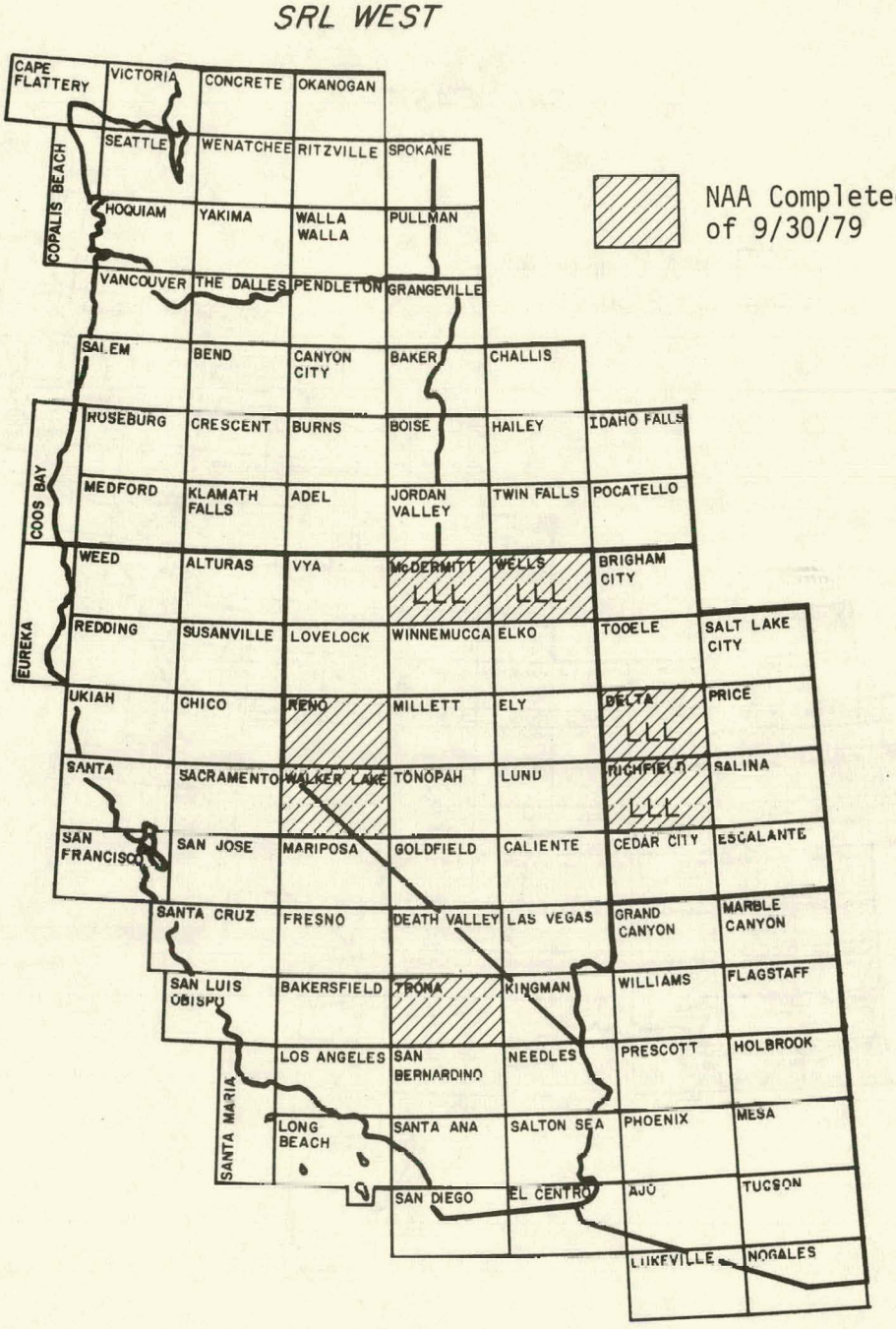



**FIGURE A-3. Neutron Activation Analyses Completed Through September 30, 1979, in SRL East**




Note: Quadrangles marked LLL were sampled by Lawrence Livermore Laboratory and were analyzed by SRL.

**FIGURE A-4. Neutron Activation Analyses Completed Through September 30, 1979, in SRL West**

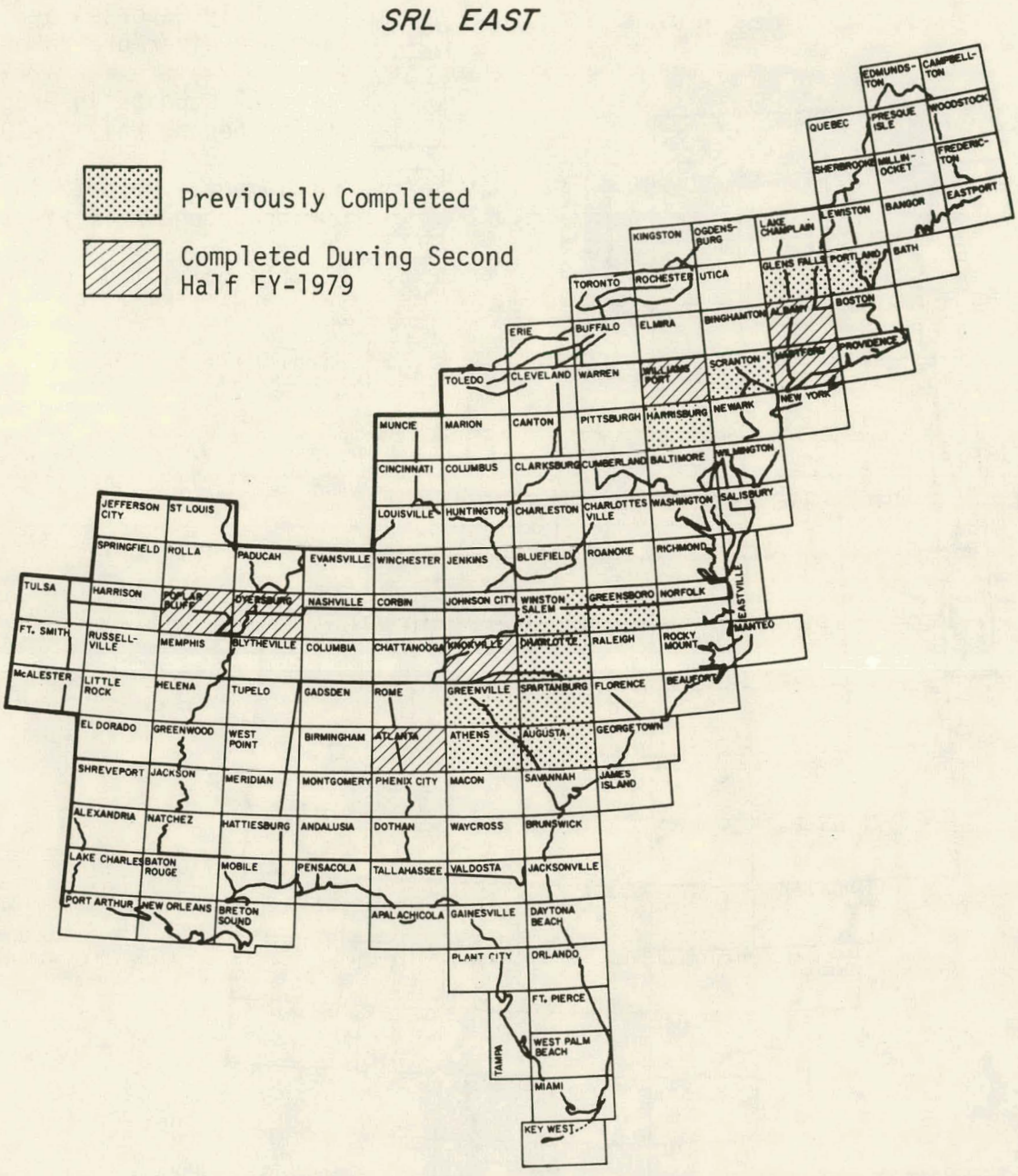



**FIGURE A-5. Data Reports Completed Through September 30, 1979, in SRL East**

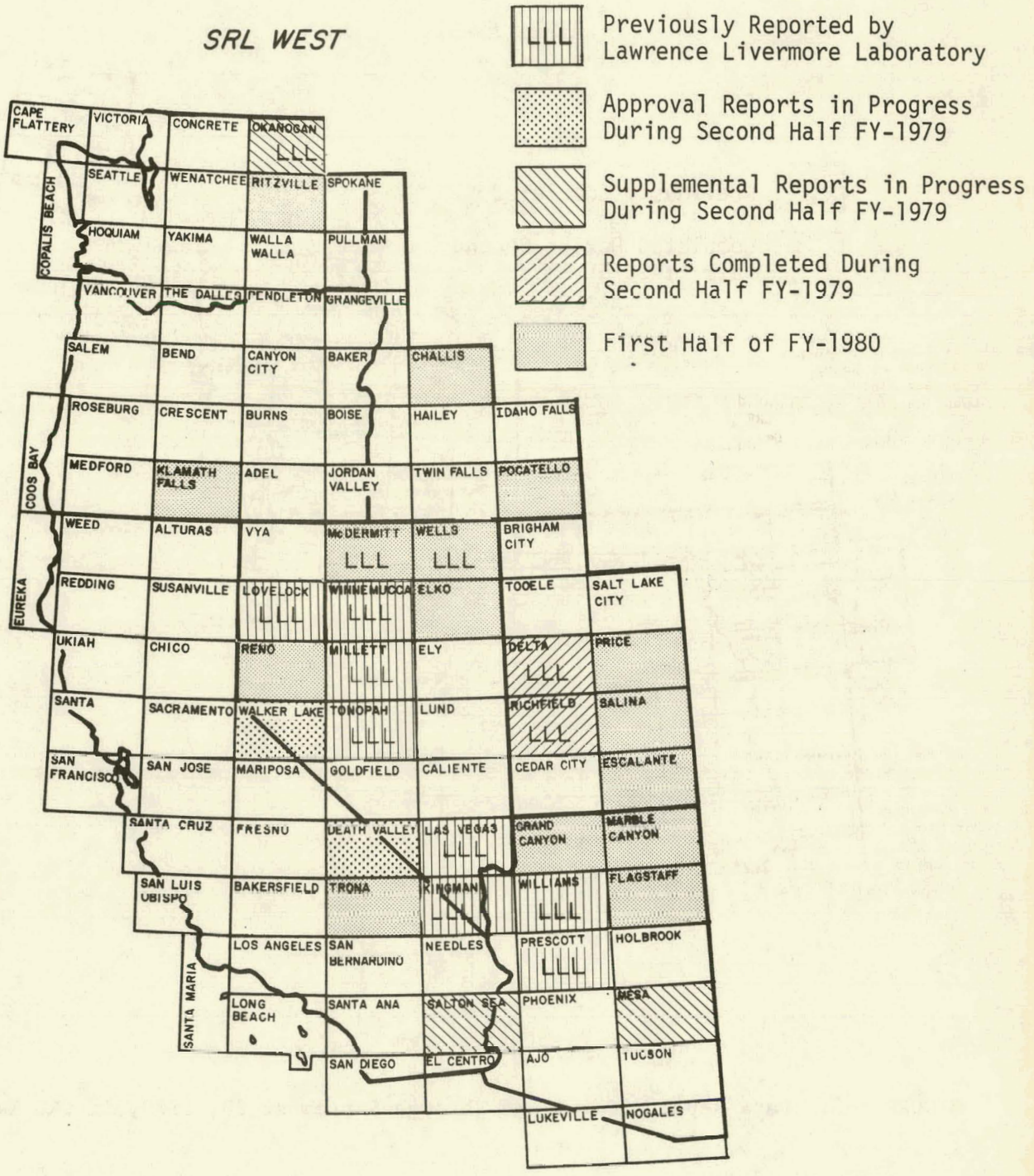



**FIGURE A-6. Data and Supplemental Data Reports Completed Through September 30, 1979, in SRL West**

**DISTRIBUTION**

Copy No.

1-100 DOE-GJ (for open file)

101 Robert J. Wright, Jr.
Chief Geologist, URE
Federal Bldg., USDOE
12th and Pennsylvania Ave., N.W.
Washington, DC 20461

102 D. L. Everhart, Manager
Department of Energy
P. O. Box 2567
Grand Junction, CO 81501

103 David H. Dahlem, Project Officer
NURE Project Office
Department of Energy
P. O. Box 2567
Grand Junction, CO 81501

104-105 Donald E. Livingston
Manager, Geochemical Department, DADD
Bendix Field Engineering Corp.
P. O. Box 1569
Grand Junction, CO 81501

106-107 Terry W. Offield
Branch of Uranium & Thorium Resources
USGS
MS 964
P. O. Box 25046
Denver Federal Center
Denver, CO 80225

108 John W. Arendt
Union Carbide Corp.
Nuclear Division - MS 246
P. O. Box P
Oak Ridge, TN 37830

109 Manager
Technical Information Center
Department of Energy
P. O. Box E
Oak Ridge, TN 37830

110-111 W. Morris
Alternate Group Leader, J-5
Los Alamos Scientific Laboratory
MS 586
P. O. Box 1663
Los Alamos, NM 87545

112 Daniel D. Bacon
USDA - Forest Service
Watershed and Minerals Unit
1720 Peachtree Rd., NE
Atlanta, GA 30309

113 Dr. Ken Holtji, Ass't Director
USDA - Forest Service
Watershed Unit
633 W. Wisconsin Ave.
Milwaukee, WI 55202

114-124 SRL-NURE

125-128 DOE-SR

129-200 TIS File, SRL