DISTRIBUTION

Docket File 40-8768
PDR/DCS
DBangart, RIV
SGrace
WDEQ (2)
JHaes, RCPD, WY
LLO Branch, LLWM
URFO r/f

40-8768/SRG/87/12/10/3



JAN 19 1988

URFO:SRG
Docket No. 40-8768
License No. SUA-1387
040008768552S

MEMORANDUM FOR: Docket File No. 40-8768

FROM: Scott R. Grace, Project Manager
Licensing Branch 1
Uranium Recovery Field Office, Region IV

SUBJECT: SAFETY EVALUATION REPORT (SER) FOR THE RENEWAL OF THE SEQUOYAH FUELS CORPORATION Q-SAND/O-SAND R&D ISL PROJECT

Attached is the Safety Evalaution Report (SER) prepared in support of the renewal of Source Material License SUA-1387 for Sequoyah Fuels Corporation Q-Sand/O-Sand Project, located in Converse County, Wyoming.

/s/
Scott R. Grace, Project Manager
Licensing Branch 1
Uranium Recovery Field Office
Region IV

Approved by: /s/
Edward F. Hawkins, Chief
Licensing Branch 1
Uranium Recovery Field Office, Region IV

Attachment: Sequoyah Fuels Corporation SER

Case Closed: 040008768552S



| OFC | URFO SRG | URFO EHH | | | | |
|---|---|---|---|---|---|---|
| NAME | SGrace/lv | EHawkins | | | | |
| DATE | 88/01/15 | 1/19/88 | | | | |

# SAFETY EVALUATION REPORT

# FOR RENEWAL OF

# SOURCE MATERIAL LICENSE

# FOR

# SEQUOYAH FUELS CORPORATION

# Q-SAND/O-SAND R&D ISL PROJECT

# CONVERSE COUNTY, WYOMING

# DOCKET NO. 40-8768

# LICENSE NO. SUA-1387

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

## LIST OF TABLES



## LIST OF FIGURES

## 1.0 INTRODUCTION

By letter dated May 27, 1986, Sequoyah Fuels Corporation (SFC) applied for renewal of Source Material License SUA-1387. On July 9, 1986, USNRC issued its notice of timely renewal to SFC allowing the project to continue to operate pursuant to 40 CFR 40.43, until such time as a final renewal decision is made. SFC submitted additional renewal material on June 15, September 17, and December 14, 1987.

### 1.1 Description of the Proposed Action

The purpose of the proposed action is to renew SFC's license for continuation of the research and development in situ leach solution mining project.

### 1.2 Background Information

Sequoyah Fuels Corporation (SFC) applied to the USNRC for renewal of Source Material License SUA-1387. The facility, known as the Q-Sand/O-Sand in situ leach project, is a research and development scale operation.

The project is situated on approximately 10 acres in west-central Converse County, Wyoming, approximately 17 miles northeast of the town of Glenrock.

The R&D project consists of two ore zones, the Q-Sand and the O-Sand. The Q-Sand well field was in operation from October 1981 through March 1986, and was determined to be restored by the USNRC on August 11, 1987. This Safety Evaluation Report (SER) primarily covers the renewal of activities of the O-Sand well field and the uranium recovery plant. Although the Q-Sand well field has been restored, no well field abandonment has taken place nor has the area been decontaminated or reclaimed . Therefore, this SER will also cover decommissioning and clean up of the Q-Sand area well field and associated ancillary facilities.

### 1.3 Review Scope

This document details the staffs' review of the facility's radiological safety program for continued operation of the Q-Sand/O-Sand R&D project. The review includes a staff analysis of the renewal application as well as previous operational monitoring data for the facility.

## 2.0 AUTHORIZED ACTIVITIES

The renewed license will authorize continued research and development scale operations of the project. Uranium will be extracted from the O-Sand orebody by injecting a sodium bicarbonate lixiviant. The uranium-rich solution will be recovered, concentrated, and packaged in the form of a wet slurry and transported to an offsite facility for drying and further processing.

### 2.1 Facility Description

The R&D facility is located in the South Powder River Basin, approximately 17 air miles northeast of the town of Glenrock, and approximately 23 air miles northwest of the town of Douglas, in Converse County, Wyoming, as shown in Figure 2.1.01. Figure 2.1.02 shows the specific location of the two well fields in relation to the recovery plant. The total surface area affected by the research and development facility is approximately 10 acres. The Q-Sand well field occupies less than 1 acre, the O-Sand well field occupies 1.8 acres, and the rest of the project occupies the remainder.

Primary use category of the land within the project area is for livestock and wildlife grazing. The land is leased by Sequoyah Fuels Corporation from the State of Wyoming for uranium exploration and commercial scale development. After termination of mining activities, the area will be reclaimed and returned to its premining grazing use.

### 2.2 Operations

SFC proposes to continue to extract uranium from the O-Sand ore zone. The O-Sand ore zone is approximately 70 feet thick. During the extraction process, an aqueous solution of sodium bicarbonate and an oxidizing agent will be injected through a 5-spot pattern, with a well spacing of about 120 feet.

The resulting uranium enriched solution will be pumped from the mineralized ore zone to the processing plant to recover the uranium. After removing the uranium, the lixiviant is refortified with reagents and reinjected into the ore zone to recover additional uranium. Flow rates from the wells will vary. However, the total flow rate will be limited to a maximum plant throughput of 250 gallons per minute (gpm).

The uranium recovery in the plant begins when the uranium enriched solution enters the process building. The solution is first run through ion exchange (IX) columns, which selectively removes the uranium compounds from the well-field waters. The uranium, which is

loaded on the column resins, is stripped (eluted) with a strong sodium chloride or hydrochloric acid solution. In this stripping process, the chloride ions replace the uranyl carbonate complexes on the resin, forming a concentrated uranium bearing solution that is then pumped to the precipitation circuit. Following the addition of hydrochloric acid, sodium hydroxide, and hydrogen peroxide, the uranium is precipitated in the form of uranium peroxide ($UO_4$). The precipitate is partially dewatered by use of a filter press and shipped in slurry form to a uranium conversion facility. All shipments will be made in compliance with applicable regulations. A schematic flow diagram of the recovery plant is shown in Figure 2.2.01.

To assure that the process circuit stays in its present configuration and is not changed without adequate health and safety considerations, the licensee will be prohibited by license condition from making major changes in the process circuit without prior approval of the corporate radiation safety officer (RSO) and the USNRC.

## 3.0 FACILITY ORGANIZATION AND ADMINISTRATIVE PROCEDURES

### 3.1 Organization

Figure 3.1.01 shows the SFC organizational structure. The SFC Corporate Medical Director, a Kerr McGee Corporate Vice President, has the overall responsibility for the radiation safety programs at the SFC facility. The on-site Radiation Safety Technician (RST) reports via an independent chain through the Corporate Radiation Safety Officer (RSO) to the Corporate Vice President/Corporate Medical Director. The RST has the authority to cease operation based upon radiological and safety considerations.

The SFC Plant Superintendent is the ranking individual on site and has the responsibility for conducting daily operations as well as industrial and radiation safety on a day-to-day basis at the Q-Sand/O-Sand ISL facility. The SFC Plant Superintendent has the authority to terminate immediately any activity at the project that is determined to be a threat to health or property.

### 3.2 Radiation Safety Staff and Responsibilities

The Radiation Safety Technician (RST), located on site, reports directly to the Plant Superintendent on matters dealing with radiation safety. The RST has the responsibility for assuring that all in-plant and environmental radiation surveys and employee's exposures are measured, calculated, documented, as well as

maintaining appropriate records. The RST performs facility inspections to assure compliance with license conditions and conducts daily walk-through inspections of the facility during the 5-day work week (not including formal holidays). Additionally, the RST reviews facility work orders to assure prescribed radiation safety procedures are followed. The RST reviews facility operating and monitoring procedures annually for compliance with radiation safety policies and regulatory compliance.

The RSO plans and administers the ALARA (As Low As Reasonably Achievable) audit and radiation safety training program. The RSO has authority to review and concur on plans for new equipment or changes in processes or procedures that could adversely impact radiation safety or the ALARA program, and has the authority to enforce regulations and corporate policies that affect any aspect of these programs.

To assure that the radiological safety of the employees is adequately monitored and controlled, the SFC RST and RSO are required by license condition to fulfill specific responsibilities and have minimal qualifications. SFC has committed that the RST and RSO will have the qualifications and responsibilities, as discussed below. License condition will also specify that the RST's and RSO's qualifications and responsibilities will be consistent with those recommended in Sections 1.2, 2.41 and 2.42 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable."

The RST shall have one of the following combinations of education, training, and experience: (1) an associate degree or 2 or more years of study in the physical science, engineering, or a health-related field; (2) at least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to uranium mills; (3) 1 year of work experience using sampling and laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill; or (1) a high school diploma; (2) at least 3 months of specialized training (up to 1 month on-the-job training) in radiation health protection relevant to uranium mills; (3) 2 years of relevant work experience in applied radiation protection. The RST should demonstrate a working knowledge of the proper operation of health physics instruments used in the mill, surveying and sampling techniques, and personnel dosimetry requirements.

The RSO should have the following education, training and experience: (1) a bachelor's degree in the physical sciences,

industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill radiation protection (2 years of relevant experience are generally considered equivalent to 1 year of academic study); (2) at least 1 year of work experience relevant to uranium mill operation in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work; (3) at least 4 weeks of specialized classroom training in health physics specifically applicable to uranium milling. In addition, the RSO should attend refresher training on uranium mill health physics every 2 years; (4) a thorough knowledge of the proper application and use of all health physics equipment used in the mill, the chemical and analytical procedures used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of uranium milling processes and equipment used in the mill and how the hazards are generated and controlled during the milling process.

3.3 Administrative and Operating Procedures

SFC has written standard operating procedures, required by license condition, for all activities involving radioactive materials that are handled, processed, stored, or transported by employees. These procedures enumerate pertinent radiation safety procedures to be followed. Standard operating procedures also exist for in-plant and environmental monitoring, bioassay analysis, and instrument calibration for activities involving radiation safety. Copies of the written procedures are kept in the work areas where they are used. All new procedures involving radiation safety are reviewed and approved in writing by the RSO. On an annual basis, the RST reviews, approves and, as necessary coordinates the updating of the standard operating procedures.

For work where the potential for significant exposure to radioactive material exists and which has no standard operating procedure, a Radiation Work Permit (RWP), called a Special Work Permit by SFC, will be required by license condition. The RWP describes the scope of the work, precautions necessary to maintain radiation exposures ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The RWP is reviewed and approved in writing by the RST, or a designated supervisor in the absence of the RST, prior to initiation of the work.

3.4 ALARA Audits and Inspections

SFC has committed, in their renewal application, to an ALARA program for radiation exposures which includes the following: (1) a

Radiation Safety Technician (RST) assigned full time at the site; (2) dissemination and posting of information and policy statements on radiation safety; (3) annual ALARA audits of the radiation safety program; (4) a site Health Physics Manual; and (5) annual radiation safety refresher training.

The licensee will be required by license condition to submit a copy of the annual ALARA audit, including detailed summaries of the analytical results of the radiological surveys, to the USNRC for staff review. In order for the USNRC to evaluate the ALARA audit, the licensee will be required by license condition to have the following minimal records reviewed as part of the annual ALARA audit: (1) bioassay results, including any actions taken when results exceed action levels in Table 1 of Regulatory Guide 8.22, "Bioassay at Uranium Mills;" (2) exposure records of external and internal time-weighted calculations; (3) safety meeting minutes, attendance records, and training program records; (4) daily inspection log entries and summary reports of the monthly reviews; (5) in-plant radiological survey and monitoring data as well as environmental radiological effluent and monitoring data; (6) surveys required by radiation work permits; (7) reports on overexposure submitted to the USNRC, MSHA or the State of Wyoming; and (8) reviews of operating and monitoring procedures completed during the period. The ALARA audit will also be specific in addressing any noticeable trends in personnel exposures for identifiable categories of workers and types of activities, any trends in radiological effluent data, and the performance of exposure and effluent control equipment. Additionally, the ALARA audit will discuss the utilization and function of exposure and effluent equipment, as well as any recommendations to further reduce personnel exposure or environmental releases of uranium or radon and radon progeny.

## 3.5 Radiation Safety Training

The licensee has committed to a program where all permanent site employees will attend a training program conducted by the RST or another qualified individual on the basic principles of radiation safety, health hazards of exposure to uranium, personal hygiene practices for uranium facilities, radiation safety procedures, and responses to emergencies or accidents involving radioactive materials. A written examination will be given at the completion of the training and the instructor will review all questions which are incorrectly answered with the trainees. Each worker must achieve a predetermined passing score before being allowed to work in a controlled or restricted area of the recovery plant. A written examination for all employees will be maintained on file.

All permanent facility workers will also receive an annual refresher training course including a review of any new radiation safety regulations, site safety experience and radiation exposure trends. Radiation safety problems as well as health physics topics will also be subjects for discussion at least six times per year in the general safety meetings. Safety meeting subjects and attendance records will be maintained on file at the site. Specialized instruction on the radiation health and safety aspects of jobs involving higher than normal exposure risks will be provided by the RST or designee.

This training program will be required by license condition and as described in Section 2.5 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As Is Reasonably Achievable."

Additionally, the licensee will be required by license condition to assure that any visitor, including contractors, registers at the office and is given appropriate instruction in the areas of radiation protection, security and safety, prior to any activities in controlled or restricted areas.

## 4.0 RADIATION SAFETY CONTROLS AND MONITORING

### 4.1 Ventilation and Air Effluent Control

The process building is vented to the atmosphere to control potential build up of radon concentrations. As discussed in Section 4.5, operational data indicate that radon progeny and average airborne uranium as measured in several areas in the process building are low. However, a review of operational data for the yellowcake press area, as contained in ALARA audits, indicates that individual airborne uranium concentrations are somewhat elevated. This situation if further evaluated in Section 4.1.

### 4.2 In-Plant Monitoring Data

Previous in-plant monitoring for radon progeny indicate that the ventilation systems are efficient in removing these radionuclides from the process building. However, airborne uranium in the yellowcake press area has had high individual values, even though the average values are low. The high individual values have exceeded the MPC during the last four semiannual ALARA audits (see Figure 4.2.01). Historical operational data indicate that airborne uranium in the yellowcake press area has been increasing since 1985 (see Table 4.2.01). The average percent MPC from initiation of operations through 1985, was 4 percent of the MPC. From the end of

1985 through October 1987, the average has increased to 9 percent of the MPC.

Although average airborne uranium concentrations have been increasing, average radon progeny concentrations in the general process area (as measured in the locations specified in Figure 4.2.02) have been decreasing. This trend is shown in Figure 4.2.03. Figure 4.2.04 shows the relationship of the average radon progeny and the highest value for each ALARA audit. Furthermore, time-weighted exposure results are also low (see Table 4.2.01), indicating that the yellowcake press operators are not receiving the exposures. This is most likely due to the limited amount of time operators spend in the yellowcake press area.

In the staff review of SFC's latest ALARA audit, the increasing (and high) airborne uranium concentrations were investigated. Numerous discussions with SFC have resulted in several new commitments by SFC (December 14, 1987 submittal) which the staff believes will reduce the potential for increased airborne uranium uptake by the operators. These commitments will be referenced by license condition and include:

- Sample heads of fixed air samplers in the yellowcake area will be no more than 7 feet above the floor when sampling during the press loading and unloading operations.

- Air volume meters on the air samplers in the yellowcake press area will be checked against a master meter and recalibrated, if needed, at least once per month for periods when the yellowcake press is being used.

- The master meter used for checking the air sample meter in the yellowcake press area will be calibrated at least annually.

- An additional airborne uranium sample station will be established near location 2 on Figure X-3 of the application for license renewal, and a sample will be collected at this station at least once per month to include a press loading and unloading cycle for periods when the yellowcake press is being used.

- To document that the yellowcake area fixed air samplers are representative of the breathing zone, a 1-month sampling program using both lapel samplers and fixed air samplers will be conducted, and the results will be submitted to NRC within 60 days of completing the test.

- Plant operators will be required to wear half masks while unloading the yellowcake press and will be required to wash down the area after the press is unloaded. These programs will be set forth as requirements in SFC's operators manual.

In summary, SFC proposes to monitor airborne uranium in two locations and radon progeny in three locations within the process building. Monitoring will be done on a monthly frequency in the locations specified in Figure 4.2.02 (Figure X-2 of the June 15, 1987 submittal). This will be specified as a license condition. These locations are representative of all work stations within the process building. Other locations will be monitored as necessary.

4.3 Personnel Monitoring Data

SFC provided details on the manner in which worker exposures, due to the inhalation and ingestion of airborne radon or its daughters and radioactive particulates of uranium, would be determined. The regulations within 10 CFR 20.103(a)(1) and (2) require the control and assessment of exposure to radon and its daughters on a calendar year basis; whereas, the soluble form of uranium (yellowcake) must be evaluated and controlled on the basis of a 40-hour work week. Therefore, to assure that these regulatory objectives are met, SFC has proposed to survey, as described above, for natural uranium and radon or its daughters on a monthly frequency in the areas specified in Figure 4.2.02.

The calculation of internal exposure to radon or its daughters and uranium will be based on a time-weighted exposure (TWE) calculation incorporating a consideration of both occupancy time and average airborne concentrations. Occupancy factors will be determined from actual time card data rather than based upon a time study approach. Occupancy times will also additively consider exposures from nonroutine or clean up operations that are covered by radiation work permits. The licensee will also be required by license condition to perform and document, within one (1) week of the end of each (weekly) regulatory period, occupational exposure calculations as required by 10 CFR 20.103(a)(2) and 10 CFR 20.103(b)(2).

Occupancy factors and airborne concentrations will be determined for use in determining employee exposure. The exposure calculation will be based upon MPC-hours. Operational data for the site indicates that employee exposures to uranium particulates and radon daughters have averaged 1.6 MPC-hours on a monthly basis (see Table 4.2.01), considering the operation of the press (the highest monthly value was 12 MPC-hours). The average for maintenance workers (not including the press operators) was 0.3 monthly MPC-hours. All exposure calculations will be maintained in the employee's personnel

files and reviewed on a quarterly basis to assure that no employee exceeds the regulatory limit of 520 MPC-hours in a calendar quarter. As previously discussed, a weekly exposure determination will be required to assure that the 40-hour control limit for soluble uranium has not been exceeded.

Should exposures exceed 25 percent of the MPC, based upon a calculated TWE for the weeks or calendar quarter, SFC will be required by license condition to conduct an investigation into the possible causes. Additionally, necessary corrective actions will be required by SFC to assure that future exposures are as low as reasonably achievable. Furthermore, the licensee will be required by license condition to maintain all survey and monitoring data as well as reports on audits and operations for a minimum period of five (5) years.

## 4.4 External Radiation Control Program

### 4.4.1 External Radiation Surveys

As during the previous operations at the SFC facility, SFC commits that all employees entering or working in the IX plant controlled area will wear either thermoluminescent dosimeters (TLDs) or film type dosimeters. During historical operations, monitoring data indicated that the dosimeters were exchanged and read on a quarterly frequency. Average quarterly exposures were 5 to 10 mRem. Employees had, on occasion, received an external dose of 25 to 40 mRem. SFC reports that this is due to maintenance work in the area of the ion exchange columns. The exposure values from the operational record are well within the regulatory limit of 1,250 mRem/quarter and the SFC action level of 312 mRem/quarter. However, to assure that the quarterly doses associated with external radiation are appropriately determined, all SFC employees will be required by license condition to wear dosimeters that are read on a quarterly basis.

### 4.4.2 Exposure to External Radiation

In addition to the TLD data discussed above, SFC will be required by license condition to assure that the results of a quarterly gamma survey in the locations specified in Figure 4.4.01 (Figure X-3 of the June 15, 1987 submittal), will be evaluated. The evaluation will identify any areas accessible to personnel where the gamma exposure rates meet the definition of a "radiation area" as stated in 10 CFR 20.202(b)(2). If such an area is identified, SFC will appropriately post it. Operational records indicate that the

areas surrounding the IX columns and yellowcake storage may need to be posted as "radiation areas."

SFC will be required by license condition to assure that all process and maintenance workers who work in the yellowcake area or work on equipment contaminated with yellowcake, wear protective clothing. Additionally, SFC has committed (December 14, 1987 submittal) that plant operators loading and unloading the yellowcake press will wear half-mask respirators (see Section 4.2).

## 4.5 Internal Radiation Control Program

### 4.5.1 Airborne Radioactivity Surveys

As discussed in Section 4.2, SFC's in-plant air monitoring program consists of monthly sampling for radon daughters and airborne uranium. SFC's airborne radioactivity survey program has been critically assessed by NRC due to the increasing airborne uranium concentrations and the individual high values exceeding MPC. The NRC has determined that SFC's December 14, 1987 commitments concerning airborne uranium monitoring are adequate to characterize personnel exposures and limit potential exposures.

### 4.5.2 Exposure to Internal Radiation

Radiation exposures at the various worker stations are primarily a function of the time spent at the station and the air concentration of uranium and radon daughters. As previously discussed, the licensee has provided venting of the facility to limit the amount of radionuclides contained in the various enclosed areas and is attempting to reverse the upward trend in airborne uranium. SFC proposes to sample airborne uranium in the yellowcake press area as well as in the general plant area, as specified in Figure 4.4.02 on a monthly frequency. Additionally, radon daughters will be sampled on a monthly frequency in the three locations shown in Figure 4.4.02. Previous air monitoring and SFC's commitments to monitoring indicate that this sampling frequency is adequate for determination of employee exposures. The USNRC will require that any time a radiation work permit is issued, a breathing zone or applicable general area air sample will be used to determine employee exposure for the specific task.

Additionally, the license will require that eating will be allowed only in administrative offices and lunch areas that are separated from the process area.

4.5.3 Respiratory Protection Program

SFC's Health Physics Manual (Section 8.6) describes respiratory protection from airborne radioactive materials. The program uses the guidelines contained in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," and NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials." SFC's personnel requirements include, in part, that before using respiratory equipment, personnel must be trained, fit tested and medically cleared for its use. Because SFC will not take credit for respirator use in determining exposures, the USNRC has no specific license condition requiring provisions for respirator use, nor has SFC's health physics manual been specifically approved by the USNRC (an in-depth review and approval has not occurred).

4.6 Bioassay

The purpose of the bioassay program is to confirm the effectiveness of the radiation protection programs and to verify the results of the calculated exposures. SFC has proposed to continue their urinalysis program consistent with the program outlined in Regulatory Guide 8.22, "Bioassay at Uranium Mills." The program includes a baseline urinalysis for all permanent employees prior to their initial assignment at the facility and monthly urinalysis for those employees who routinely work in the process plant controlled area. SFC's urinalysis program will be required by license condition. The license condition will specify an action level of 15 micrograms of uranium per liter (µgU/l). If the action level is reached or exceeded for any worker, the RST will investigate the cause, correct the situation, and report the results in the semiannual ALARA audit. Any time two consecutive urine specimens exceed 35 µgU/l, or one specimen exceeds 130 µgU/l, a report shall be submitted to the USNRC within 30 days, indicating what corrective actions have been performed. Because SFC's urinalysis program will be consistent with Regulatory Guide 8.22, the NRC has determined that SFC's urinalysis program is sufficient to adequately verify calculated exposures.

Urine samples are analyzed by vendors capable of detecting 5 micrograms of natural uranium per liter. Blanks and spikes are submitted with each group of urine samples as a quality control measure. SFC was having trouble with their quality control through the first half of 1986. During this time period, the laboratory results indicated that blanks and spikes were often having a margin of error that exceeded 30 percent. For the last three ALARA audits, the error has been less than 30 percent. The error in the program is expected to continue to be within the acceptable error.

## 4.7 Contamination Control

### 4.7.1 Personnel Contamination

SFC will be required by license condition that all process workers leaving the restricted area shall monitor themselves for alpha contamination. The monitoring will be done at the exit from the change area. Values meeting or exceeding the fixed alpha level of 1000 dpm/100 $cm^2$ will require that personnel decontaminate and resurvey themselves. Additionally, the license condition will require the licensee to perform and document spot surveys for alpha contamination at least quarterly on all employees leaving the change area. The USNRC has determined that the personnel contamination program is adequate to detect and control alpha contamination.

### 4.7.2 Surface Contamination

SFC has proposed that alpha contamination surveys of the eating and change areas be conducted weekly and surveys of the facility laboratory and offices be conducted monthly in the locations shown in Figure 4.7.01 (Table X-1 from the June 15, 1987 submittal, taken from the USNRC "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials"). A license condition shall require that if these surveys indicate that removable alpha contamination exceeds the levels indicated from Figure 4.7.01, the area will be decontaminated.

### 4.7.3 Release and Disposal of Contaminated Equipment

SFC has proposed, and will have as a license condition, that all equipment, materials and/or packages be surveyed for radiological contamination prior to release from the restricted area. This will be in accordance with the USNRC "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials." This guideline will be incorporated as an attachment to the license.

For equipment that does not meet the release to unrestricted use limits, there are two ways the equipment can be authorized to leave the sites: (1) transfer to another licensed source material facility or (2) transfer to a licensed disposal facility.

## 4.8 Quality Assurance and Calibration

SFC has committed to a quality assurance (QA) program for all sampling and analyses performed as part of the radiation safety program. The QA program is equivalent to all of the recommended elements as specified in Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Stream and the Environment," and, therefore, is acceptable to the USNRC.

SFC has committed (Section 11.3 of their Health Physics Manual, submitted June 15, 1987) that all radiation monitoring, sampling and detection equipment shall be recalibrated on a regularly scheduled basis. The NRC has determined, and will require by license condition, that the equipment be recalibrated after each repair and as recommended by the manufacturer, or at least semiannually, whichever is more frequent. In addition, all radiation survey instruments shall be operationally checked with a radiation source each day, when in use.

## 4.9 Radiological Environmental Monitoring Program

SFC's radiological environmental monitoring program is summarized in Table 4.9.01 ( modified from Table 16 of SFC's June 15, 1987 submittal). The program consists of radon, direct gamma, sediment and water sampling. The radon sampling was originally done at three locations. Due to the historically low concentrations, the USNRC authorized that two locations could be abandoned in the fourth quarter of 1985. Data will continue to be taken at the downwind location. Table 4.9.02 summarizes the results of the radiological environmental monitoring for the fourth quarter 1985 through the second quarter 1987.

Historically, SFC has been sampling water from the outfall of the water treatment settling ponds, prior to mixing with the receiving stream. Because the discharges from the process plant will now be treated with barium chloride in settling tanks prior to mixing with water from the Bill Smith Mine, (rather than treating after mixing with the mine water and then discharging into the water treatment settling ponds), SFC will be required by license condition to take water samples and analyze for uranium, radium, and thorium at the outfall of the water treatment settling tanks. Samples will be taken prior to mixing with Bill Smith Mine water discharges. This is necessary to confirm that release limits to unrestricted areas are being met. Refer to the Environmental Assessment (EA) for further discussion.

The USNRC has determined that this monitoring program as discussed above is sufficient to assess the radiological environmental impacts of the operation.

## 5.0 RESTRICTED AREA MARKINGS AND ACCESS CONTROL

The SFC process plant, the yellowcake storage area, the solar evaporation ponds, the process water treatment plants, and the process water treatment settling ponds and tanks are located within different areas of SFC's fenced controlled access area, as shown in Figure 5.1.01. These areas are termed "Radioactive Material Caution Areas" (restricted areas) and are posted in accordance with 10 CFR 20.203(c). Signs reading "CAUTION - RADIOACTIVE MATERIALS" are maintained along the fences of the evaporation ponds and water treatment settling ponds, the yellowcake storage area, as well as the entrance to the water treatment plants and the process plant. Even though the releases from the process plant (through the water treatment settling tanks) to the settling ponds will now meet release to unrestricted area limits (10 CFR Part 20), the settling ponds still contain sufficient radium (byproduct material) from past processing plant discharges to warrant restricted area status. Therefore, SFC should appropriately post these areas.

Security for the site is provided by personnel working at the facility. Considering the remote location of the site and the private access road leading to it, such security measures are adequate. The three entrances to the site are marked with signs stating "CAUTION RADIOACTIVE MATERIALS - ANY AREA IN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIALS."

The USNRC concludes that the above markings and access control are adequate. A license condition will be issued which exempts SFC from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the facility, provided that all entrances to the facility are conspicuously posted in accordance with Section 20.203(e)(2) and with the words, "ANY AREA OR ROOM WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

## 6.0 EMERGENCY PROCEDURES AND PREVENTATIVE MEASURES

SFC has an Emergency Action Plan for accidents at the site (Appendix XII of the June 15, 1987 submittal), including accidents involving the release of hazardous materials and transportation of the wet yellowcake, as well as industrial accidents such as fire and explosions. The procedures specify appropriate individuals to contact and shall be referenced by license condition.

Ruptures of fluid and trunk lines are not expected to result in an emergency-type situation. Failure of a buried pipeline between the well field and the process plant would be detected due to the decreased flow to the process plant. Furthermore, the radionuclide content of such a

solution spill would be minimal due to the low activity of the production solution. A spill or pipeline rupture within the process building would be detected almost immediately. Any solution resulting from this type of failure would be directed to process solution sumps, retained in the mill process or diverted to the solar evaporation ponds.

Transportation accidents may result in a release of radioactive materials outside of the control of the facility. Review of the SFC procedure discussing these types of accidents indicates a thorough and complete chain of command and notification procedures.

The potential for the release of radioactive materials as a result of adverse weather phenomena or earthquakes is extremely low since tornadoes or similar types of severe weather are few, and the mill is located in a low seismic activity area.

Accidents involving the failure of the solar evaporation ponds would be extremely remote. As required by license condition, the licensee will perform a daily inspection of the solution evaporation ponds, on a 5-day a week basis, to check for signs of embankment stress as well as compliance with freeboard requirements.

The licensee will also be required (as discussed in the EA) to notify the USNRC, Uranium Recovery Field Office, within 48 hours by telephone, of any failure of any solution pond, any break or rupture of any pipeline or other similar failure of any other fluid or material conduit or storage facility which results in a release of radioactive material and/or of any unusual conditions which if not corrected could lead to such a failure. This requirement is in addition to the requirements of 10 CFR Part 20.

## 7.0 EVAPORATION POND EVALUATION

As previously stated, the licensee has two solar evaporation ponds. The two solar evaporation ponds are lined with hypalon, have leak detection sumps and have been designed and constructed in accordance with acceptable engineering standards. The solar evaporation ponds have a designated freeboard of 3 feet to ensure that they will not overflow and that in the event of a leak in one pond, it's contents can be transferred to the other.

## 8.0 DECOMMISSIONING AND RECLAMATION

SFC will be required by license condition to decommission and reclaim the site to appropriate radiation protection standards. Since SFC has not submitted a decommissioning plan, SFC will be required by license condition to submit a decommissioning plan 90 days prior to the end of restoration of the O-Sand well field. Additionally, all production and

injection wells will be required to be abandoned in accordance with the State of Wyoming standards.

## 9.0 SURETY REQUIREMENTS

The staff will require by license condition that the licensee maintain an USNRC-approved financial surety, consistent with 10 CFR 40, Appendix A, Criterion 9. The surety will be adequate to cover the estimated costs for restoration, decommissioning, decontamination and reclamation. All associated costs calculated will be based upon the hiring of a contractor (third party) to perform the work. The surety shall be updated annually in order to allow adjustments of the surety total.

## 10.0 COMPLIANCE INSPECTION HISTORY

A chronological listing of SFC's compliance history is given since 1982.

### October 6, 1982 Inspection

One item of noncompliance was identified:

> Violation 1 - Contrary to License Condition No. 11, documentation was not maintained of calibration data for equipment used to calibrate air samplers.

The licensee's corrective action was sufficient.

### June 27 and 28, 1984 Inspection

One item of apparent noncompliance was identified. However, SFC's response was such that this item was not considered an item of noncompliance.

### June 3, 1985 Inspection

No items of noncompliance were identified.

### October 28, 29 and 30, 1986 Inspection

Three items of apparent noncompliance were identified. Two of these items were considered not to be items of noncompliance based upon the licensees' response. Therefore, one item of noncompliance was identified:

> Violation - License Condition No. 60 requires, in part, that individuals performing inspections of the solution evaporation ponds have training in proper inspection techniques.

Contrary to the above, the licensee could not produce documentation of such training.

The licensee's corrective actions were sufficient.

The licensee has had two violations over the period of record. However, the violations have been corrected in a satisfactory and timely manner. Additionally, the audit and inspection programs as described in Section 3.5 of this SER will ensure that proper management attention is given to conducting operations in accordance to the license.

## 11.0 CONCLUSION INCLUDING SAFETY LICENSE CONDITIONS

Based upon the SFC renewal application, as well as the discussion contained in this SER, the USNRC has concluded that the operation of the Q-Sand/O-Sand project, in accordance with the commitments in SFC submittals and the following license conditions, will be protective of health and safety and fulfill the requirements of 10 CFR Part 20.

The staff therefore recommends that Sequoyah Fuels Corporation be issued a renewed source material license subject to the following conditions:

1. Any major changes in the process circuit, as illustrated and described in Figure 1-1 of Appendix XI of the licensee's June 15, 1987 submittal shall be reviewed by the RSO and shall be submitted to the USNRC, Uranium Recovery Field Office, for prior approval in the form of a license amendment.

2. A daily walk through inspection of all operating areas shall be performed and documented by the RST or his trained designate, on a five day a week basis, to ensure that all radiation protection and monitoring requirements are being followed.

3. In addition to the responsibilities and qualifications as specified in Appendix X of the licensee's June 15, 1987 renewal application, the Radiation Safety Officer (RSO) shall be qualified as specified in Sections 1.2 and 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As Reasonably Achievable," dated May 1983.

4. The licensee shall have a Radiation Safety Technician (RST) assigned full time to the site who shall report directly to the project manager on matters dealing with radiological safety. The RST shall have the qualifications as specified in Section 2.4.2 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As Reasonably

Achievable," dated May 1983, and the responsibilities as specified in page 2 of Appendix X of the licensee's June 15, 1987 submittal.

5. Standard operating procedures (SOPs) shall be established for all operational activities involving radioactive materials that are handled, processed or stored. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for nonoperational activities to include in-plant and environmental monitoring, bioassay analysis and instrument calibration. An up-to-date copy of each written procedure shall be kept in each area where it is used.

   All written procedures for both operational and nonoperational radiation related activities shall be reviewed and approved in writing by the RSO before being implemented and whenever a change in a procedure is proposed. The RST shall review and approve all existing facility procedures on an annual basis.

6. For work where the potential for exposure to radioactive materials exists and for which no standard written procedure exists, a radiation work permit (RWP) shall be required. Such permits shall describe the following:

   A. The scope of work to be performed.

   B. Any precautions necessary to reduce exposure to uranium and its daughters to as low as is reasonably achievable (ALARA).

   C. Any supplemental radiological monitoring and sampling required during and following completion of the work. Nonroutine maintenance involving exposure of workers to airborne particulates of uranium and its daughters shall require the use of continuous breathing zone monitoring.

   The RST or designee shall indicate by signature the review of each RWP prior to the initiation of the work.

7. The licensee shall perform a annual ALARA audit of the radiation safety program which shall be conducted by the RSO or other authorized individual with equivalent qualifications, in accordance with Section 2.3.3 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Mills will be As Low As Reasonably Achievable," dated May 1983. A report of this audit shall be submitted to the USNRC, Uranium Recovery Field Office within 60 days after conducting the audit. The report shall include detailed summaries of the analytical results of the radiological surveys. In order to evaluate the ALARA objective, the

licensee shall, at a minimum, review the following records: (A) Bioassay results including any actions taken when the results exceeded action levels in Table 1 of Regulatory Guide 8.22, "Bioassay at Uranium Mills," dated January 1987; (B) Exposure records of external and internal time-weighted calculations (TWE); (C) Safety meeting minutes, attendance records, and training program records; (D) Daily inspection log entries and summary reports of the monthly reviews; (E) In-plant radiological survey and monitoring data as well as environmental radiological effluent and monitoring data; (F) Surveys required by radiation work permits; (G) Reports on overexposure submitted to USNRC, MSHA, or the State of Wyoming; and (H) Reviews of operating and monitoring procedures completed during the period.

The audit shall also address any noticeable trends in personnel exposures for identifiable categories of workers and types of activities, any trends in radiological effluent data, and the performance of exposure and effluent control equipment as well as its utilization, maintenance and inspection history. Any recommendations to further reduce personnel exposures or environmental releases of uranium or radon and radon progeny shall be included in the report.

8. The licensee shall have a training program for all permanent site employees as described in Section 2.5 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As Is Reasonably Achievable," dated May 1983, and as detailed in page 3 of Appendix X, "Health Physics Administration" of the licensee's June 15, 1987 submittal.

9. Any visitor, including contractors, shall be required to register at the office and shall be given appropriate instruction in the areas of security, safety and radiation protection, prior to entering controlled or restricted areas.

10. The licensee shall perform monthly surveys for natural uranium in locations 1 and 2 and radon progeny in locations 2, 3, and 4, shown in Figure X-2, "Radon Progeny and Airborne Uranium Survey Locations," of Appendix X of the licensee's June 15, 1987 submittal. If radon or radon progeny concentrations exceed 8 picocuries per liter (pCi/l) or 0.08 working level (WL), respectively, sampling shall be weekly until four (4) consecutive weekly samples exhibit less than 8 pCi/l or 0.08 WL.

The calculation of internal exposure to radon, radon progeny, or natural uranium shall be based on a Time Weighted Exposure (TWE) calculation incorporating a consideration of both occupancy times

and average airborne working levels or activity concentrations. If occupancy times are established as an average for each category of worker, the licensee shall also, by means of a semiannual time study, determine the basis upon which average occupancy periods are established.

If any worker reaches or exceeds 25 percent of the maximum permissible exposure limits as specified in 10 CFR Part 20 based upon a calculated TWE for the week or the calendar quarter, dependent on the solubility of the material, the RST shall initiate an investigation of the employee's work record and exposure history to identify the source of the exposure. Necessary corrective measures shall be taken to ensure reduction of future exposures to as low as is reasonably achievable. Records shall be maintained of these investigations.

11. Occupational exposure calculations shall be performed and documented within one (1) week of the end of each regulatory compliance period as specified in 10 CFR 20.103(a)(2) and 10 CFR 20.103(b)(2). Routine radon daughter and particulates shall be analyzed in a timely manner to allow exposure calculations to be performed in accordance with this condition. Nonroutine samples shall be analyzed and the results reviewed by the RST within two (2) working days after sample collection.

12. The licensee shall issue to all site employees, either thermoluminescent dosimeters (TLD) or film type dosimeters which shall be exchanged and read on a quarterly frequency.

13. The licensee shall perform quarterly gamma radiation surveys in enclosed areas at the locations specified in Figure X-3, "Gamma Radiation Survey Locations," in Appendix X of the licensee's June 15, 1987 submittal.

14. The licensee shall require that all process and maintenance workers who work in yellowcake areas or work on equipment contaminated with yellowcake, wear protective clothing including coveralls and boots or shoe covers. Workers who package yellowcake slurry for transport shall wear gloves.

15. Eating shall only be allowed in administrative offices, and enclosed lunch areas that are separated from the process areas.

16. The licensee shall implement a urinalysis program as outlined in Revision 1 to Regulatory Guide 8.22, "Bioassay at Uranium Mills," dated January 1987, with the following additions:

A. Baseline urinalysis shall be performed for all permanent employees prior to their initial assignment at the facility.

B. Anytime an action level of 15 micrograms uranium per liter (ug U/l) urine is reached or exceeded for any worker, the licensee shall provide documentation, in the annual ALARA audit, to the USNRC, Uranium Recovery Field Office, indicating what corrective actions have been performed to satisfy the recommendations of Revision 1 to Regulatory Guide 8.22.

Any time an action level of 35 ug U/l for two (2) consecutive urine specimens or 130 ug U/l for any one specimen is reached or exceeded, the licensee shall provide documentation within thirty (30) days to the USNRC, Uranium Recovery Field Office, indicating what corrective actions have been performed to satisfy the recommendations of Revision 1 to Regulatory Guide 8.22.

17. Before leaving the restricted area all process workers shall monitor using a calibrated alpha survey instrument. Surveys meeting or exceeding the radiation level of 1000 dpm/100 $cm^2$ shall require personnel to decontaminate and resurvey themselves. The licensee shall perform spot surveys for alpha contamination at least quarterly on all workers leaving the facility.

18. The licensee shall perform monthly alpha contamination surveys of the facility laboratory and offices and weekly surveys of eating and change areas, as specified in Figure X-1, "Area Designations IX Process Facility Contamination Survey Frequency," of the licensee's June 15, 1987 submittal. If samples are analyzed in the facility laboratory, the licensee shall survey all surfaces used for urine sample preparation preceding the analyses as specified in Section 3.5 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures are As Low As Reasonably Achievable," dated May 1983.

If the alpha contamination levels exceed those listed in Attachment No. 3 to this license, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984, the area shall be decontaminated.

19. Release of equipment, materials, or packages from the restricted area shall be in accordance with Attachment No. 3, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

20. All radiation monitoring, sampling and detection equipment shall be recalibrated after each repair and as recommended by the manufacturer, or at least annually, whichever is more frequent. In addition, all radiation survey instruments shall be operationally checked with a radiation source each day, when in use.

21. The licensee shall perform the radiological environmental monitoring program as outlined in Table 16, "Operational Surface Radiological Environmental Monitoring Program," in the licensee's June 15, 1987 submittal, with the following modification: locations for water samples will be at the outfall of the water treatment settling tanks, prior to mixing with other fluids.

22. The licensee is hereby exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for posting areas within the facility, provided that all entrances to the facility are conspicuously posted in accordance with Section 20.203(e)(2) and with the words, "CAUTION - ANY AREA OR ROOM WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

23. The licensee shall implement the Emergency Action Plan for Accidents as detailed in Appendix XII of the licensee's June 15, 1987 submittal.

24. The licensee shall submit a decommissioning plan to the USNRC, Uranium Recovery Field Office, 90 days prior to the end of restoration of the O-Sand well field.

25. The licensee shall maintain an USNRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for completion of the USNRC-approved site closure plan including; above ground decommissioning and decontamination, the cost of offsite disposal of radioactive solid process or evaporation pond residues, and ground-water restoration as warranted. Within three (3) months of USNRC approval of a revised closure plan and cost estimate, the licensee shall submit, for USNRC review and approval, a proposed revision to the financial surety arrangement if estimated costs in the newly approved site closure plan exceed the amount covered in the existing financial surety. The revised surety shall then be in effect within three (3) months of written USNRC approval. Annual updates to the surety amount, required by 10 CFR 40, Appendix A, Criterion 9, shall be provided to the USNRC at least three (3) months prior to the anniversary of the effective date of the existing surety instrument. If the USNRC has not approved a proposed revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to expiration, for one year.

Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15% contingency, changes in engineering plans, activities performed and any other conditions affecting estimated costs for site closure. The licensee shall also provide the USNRC with copies of surety related correspondence submitted to the State, a copy of the State's surety review and the final approved surety arrangement. The licensee must also ensure that the surety, where authorized to be held by the State, expressly identifies the USNRC related portion of the surety and covers the above ground decommissioning and decontamination, the cost of offsite disposal, soil and water sample analyses and ground-water restoration associated with the site. The basis for the cost estimate is the USNRC approved site closure plan or the USNRC approved revisions to the plan.

Sequoyah Fuel's currently approved surety instrument, two surety bonds in the amount of $109,000 ([redacted]) and $157,000 ([redacted]), issued by SAFECO Insurance Company of America in favor of the State of Wyoming, shall be continuously maintained for the purpose of complying with 10 CFR 40, Appendix A, Criterion 9, until a replacement is authorized by both the State and the USNRC. Attachment 1 to this license outlines the minimum considerations used by the USNRC in the review of site closure estimates. Reclamation/decommissioning plans and annual updates should follow this outline.

Table 4.2.01

| ALARA Audit Number | Audit Submittal Date | Airborne Uranium in Yellowcake | | Radon Progeny | | Time-Weighted Exposures (MPC - hours) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Operator | | Maintenance | |
| | | Press Area (Avg % MPC) | Highest % MPC | Avg % W.L. | Highest W.L. | Month Avg | Highest Month | Monthly Avg | Highest Month |
| 12 | 11/13/87 | 12 | 120 | 0.02 | 0.23 | 1.3 | 6.6 | <0.1 | <0.1 |
| 11 | 05/29/87 | 7 | 250 | 0.04 | 0.44 | 5.5 | 12 | 1.7 | 7.2 |
| 10 | 12/05/86 | 12 | 200 | 0.02 | 0.08 | 1.2 | 5.6 | - | - |
| 9 | 05/29/86 | 9 | 110 | 0.02 | 0.08 | 1.2 | 8.9 | 0.1 | 2.4 |
| 8 | 12/31/85 | 5 | 65 | 0.04 | 0.44 | 1.1 | 5.37 | 0 | 0 |
| 7 | 05/31/85 | 3 | 19 | 0.03 | 0.08 | 0.7 | 2.5 | 0.1 | 0.1 |
| 6 | 11/29/84 | 6 | 73 | 0.05 | 0.59 | 0.5 | 3.1 | 0 | 0.1 |
| 5 | 05/21/84 | 3 | 48 | 0.04 | 0.34 | 0.8 | 1.8 | 0 | 0 |
| 4 | 11/28/83 | 5 | 39 | 0.06 | 0.91 | 0.9 | 3.8 | 0 | 0 |
| 3 | 06/03/83 | 4 | 30 | 0.06 | 0.42 | 2.7 | 4.1 | 0.3 | 1.3 |
| 2 | 10/01/82 | 5 | 50 | 0.04 | 0.53 | 1.8 | 2.9 | 0.2 | 0.5 |
| 1 | 04/07/82 | 6 | 22 | 0.08 | 0.35 | 16 | 24 | 2 | 6 |

Table 4.9.01 - Operational Surface Radiological Environmental Monitoring Program

| Type of Sample | Number | Location | Method | Frequency | Type of Analysis |
|---|---|---|---|---|---|
| Radon | 3*3 | Upwind at site boundary*3<br>Downwind at site boundary<br>Pregnant leach tank*3 | Continuous or Grab[1] | Monthly or Quarterly | Rn-222 (pCi/l) |
| Direct Gamma | 4 | At same locations used for air sampling and at | Survey meter or dosimeter | Quarterly | Gamma exposure rate (μR/hr) |
| Sediment/Soil | 3 | Outfall from final treatment unit<br><br>2 locations in drainageway between Outfall and Sage Creek | Grab sample | Quarterly | Ra-226 (pCi/g - dry weight) |
| Water | 2 | Outfall of final treatment unit*4<br><br>Prior to mixture with dilutent water or receiving stream*5 | Grab sample | Quarterly | Total Ra-226 and Total Th-230 (pCi/ml) |

[1]A grab sample shall consist of at least four (4) separate forty-eight (48) hour samples using the "Tedlar Bag Method" during a period of one (1) month.
[2]Although a monthly sampling frequency is recommended, a quarterly sampling frequency is acceptable where a continuous passive radon detector is used.
*[3]Radon monitoring at upwind and leach tank locations deleted by License Amendment No. 14 (November 21, 1985).
[4]Final treatment will be considered the treatment tanks, rather than the mine water treatment settling ponds.
[5]Samples will be: prior to mixing with water from Bill Smith Mine or discharge into the water treatment settling ponds.

Table 4.9.02

Summary of Radiological Environmental Monitoring
(4th Quarter 1985 through 2nd Quarter 1987)

| | Avg. | St. Dev. | Min. | Max. |
|---|---|---|---|---|
| Radon (pCi/l) | | | | |
| -downwind | 1.3 | 1.9 | 0.3 | 9.1 |
| -percent MPC | 43 | | 10 | 300 |
| Direct Gamma (μR/hr) | | | | |
| upwind | 13.13 | 2.85 | 11 | 20 |
| downwind | 15.13 | 2.20 | 12 | 20 |
| leach tanks | 27.63 | 5.07 | 21 | 34 |
| evaporation ponds | 21.63 | 2.74 | 17 | 25 |
| Sed. Radium (pCi/g) | | | | |
| outfall | 4.26 | 2.3 | 0 | 8.9 |
| Ross Rd | 3.84 | 2.67 | 0 | 8.4 |
| downstream | 2.03 | 1.38 | 0 | 4.1 |
| Water Outfall (pCi/l) | | | | |
| Radium (average) | 1.58 | 0.67 | 0.8 | 2.5 |
| -percent MPC | 5.25 | 2.24 | 2.7 | 8.3 |
| Thorium | 0.76 | 0.45 | 0 | 1.5 |
| -percent MPC | 0.03 | 0.02 | 0 | 0.08 |

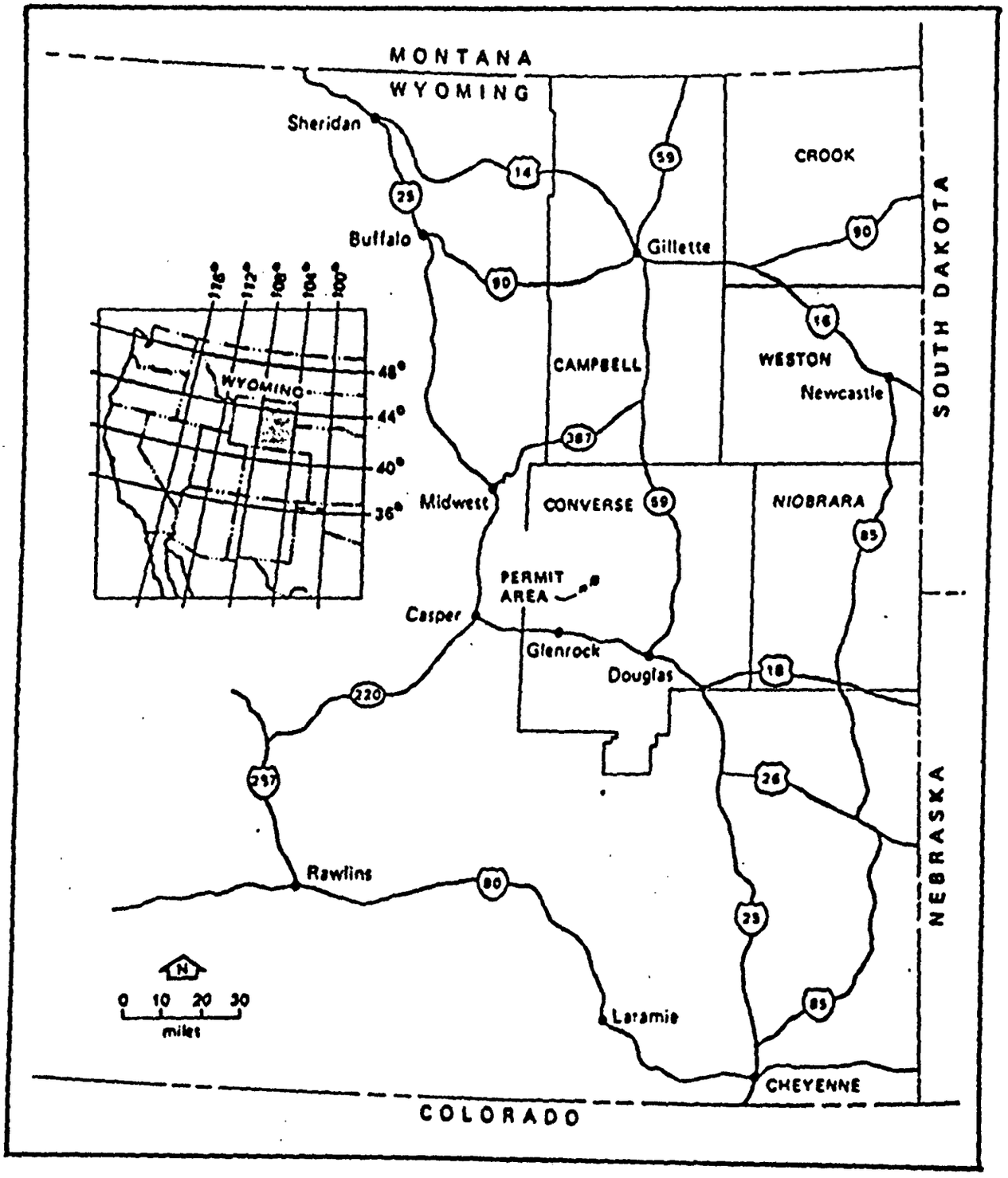


Figure 2.1.01 - Location Map

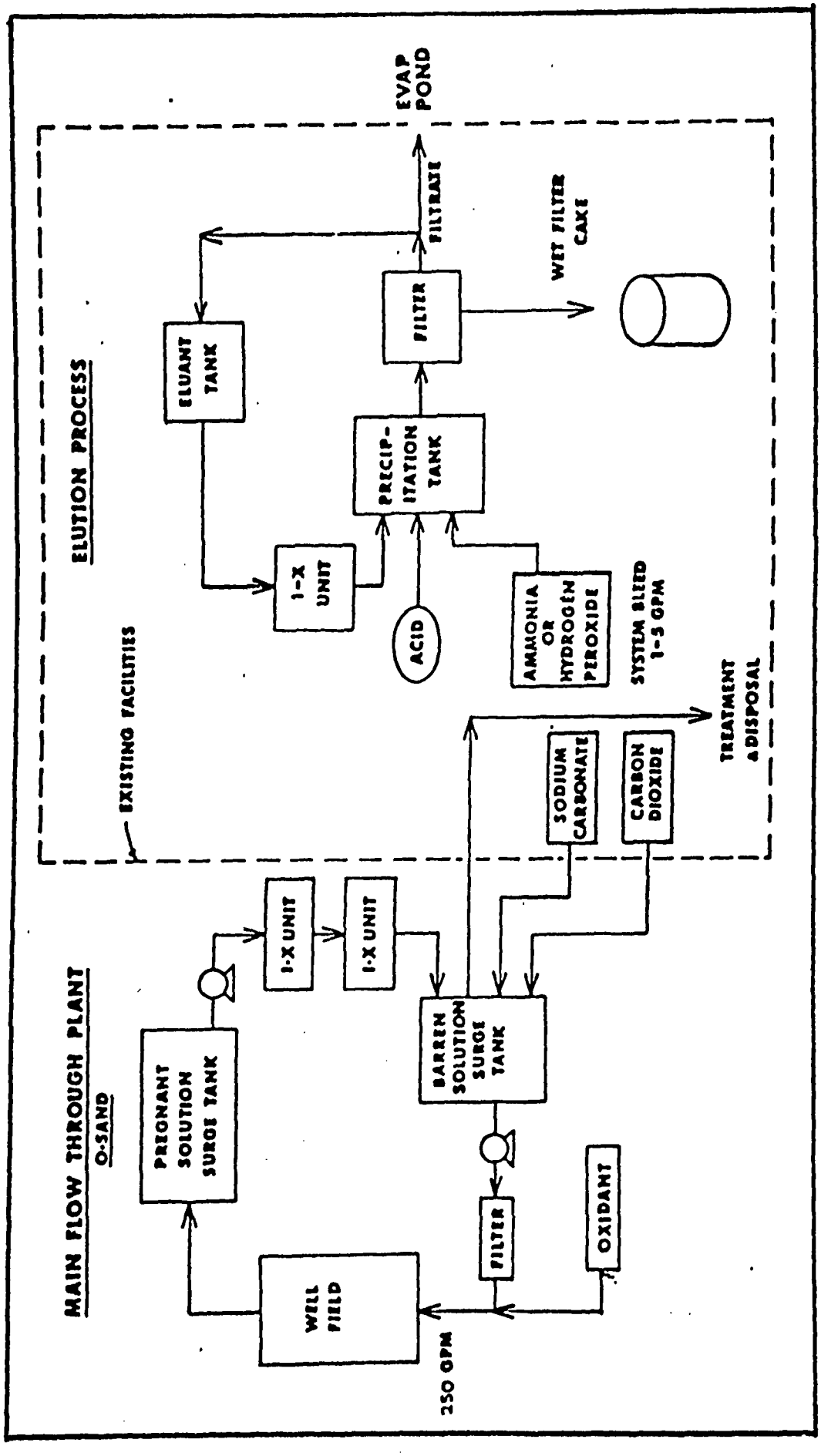


Figure 2.2.01 - Schematic Flow Diagram of Process Plant

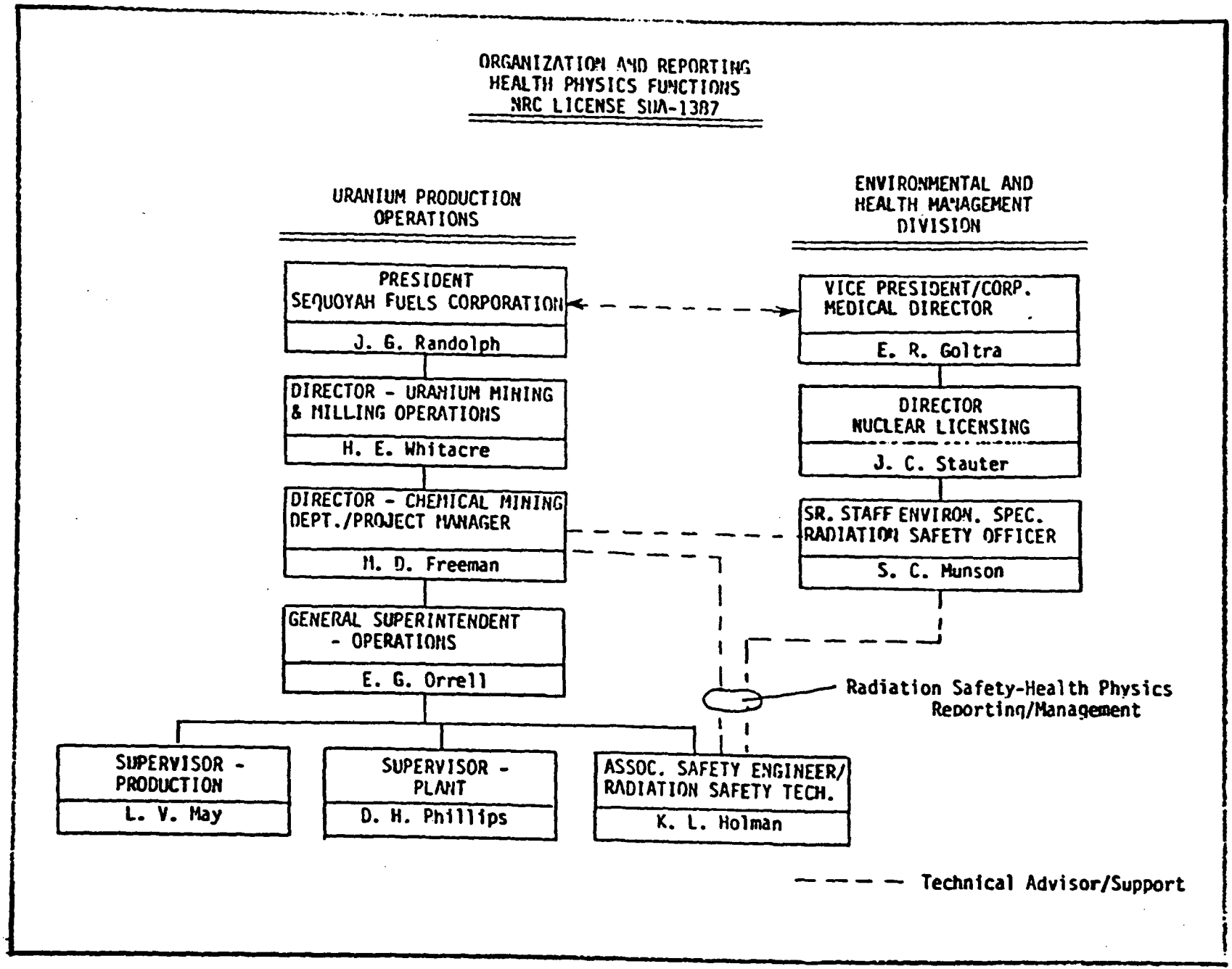


Figure 3.1.01 - Organization and Reporting Chart

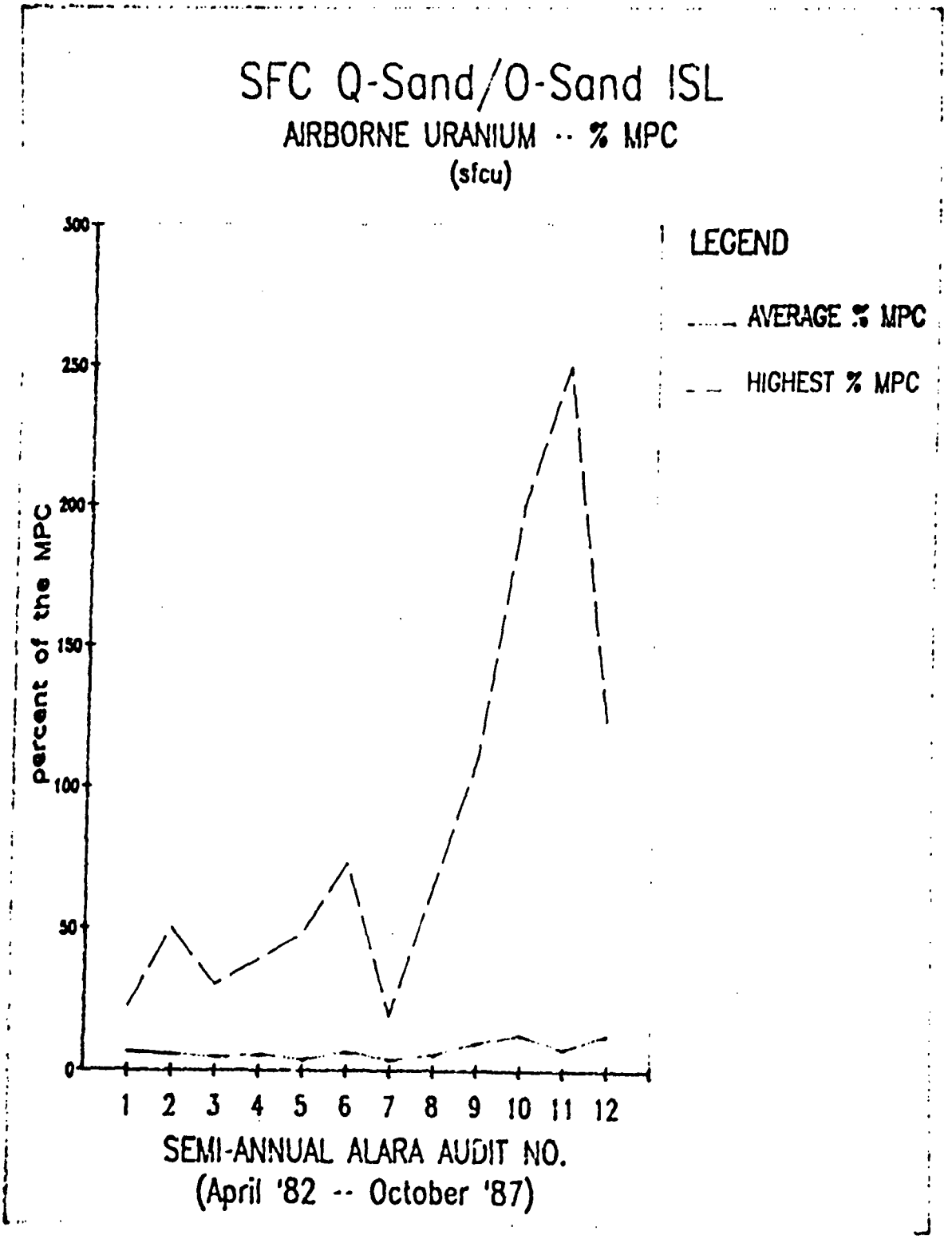


Figure 4.2.01 - Airborne Uranium

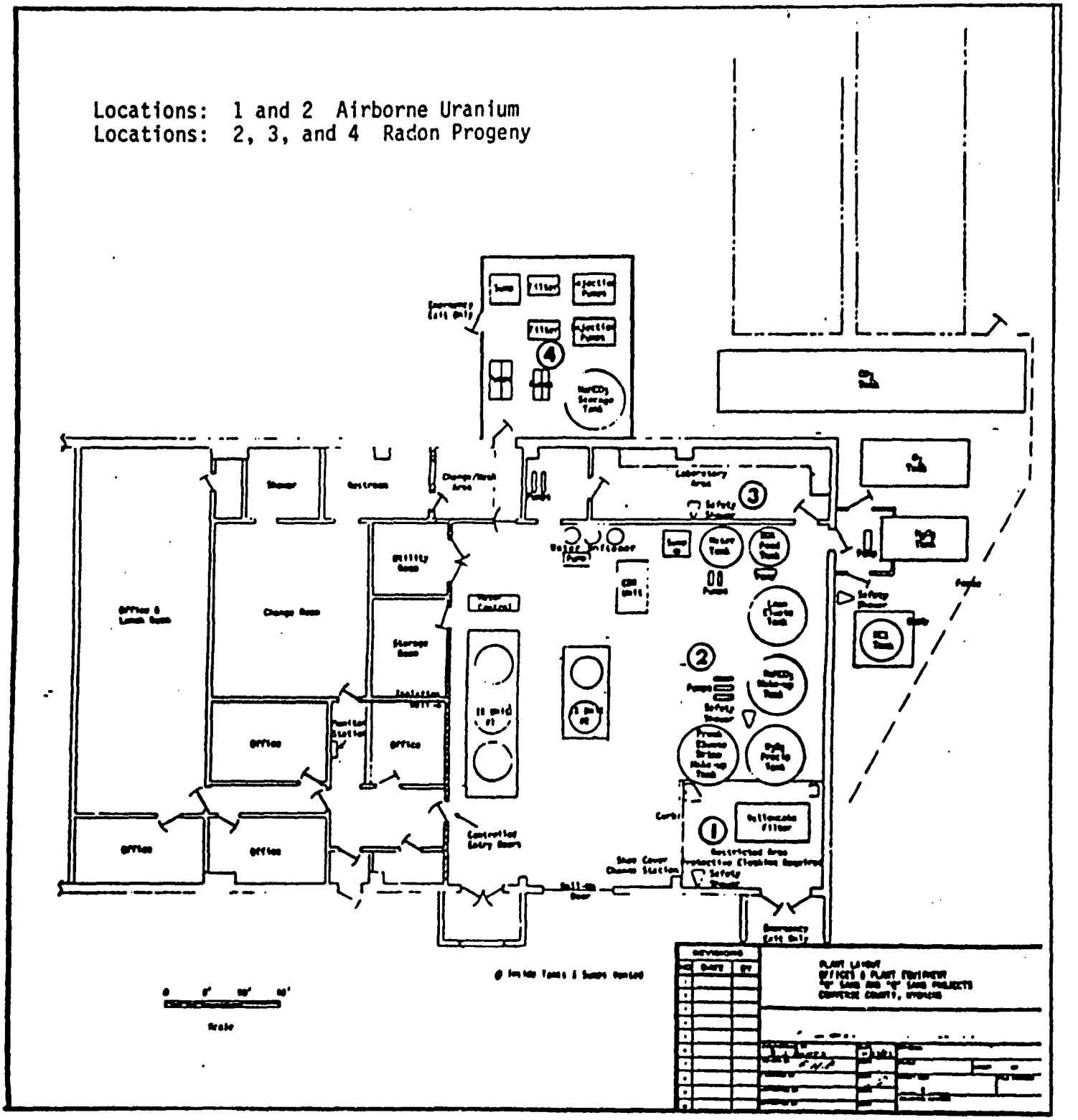


Figure 4.2.02 - Radon Progeny and Airborne Uranium Survey Locations.

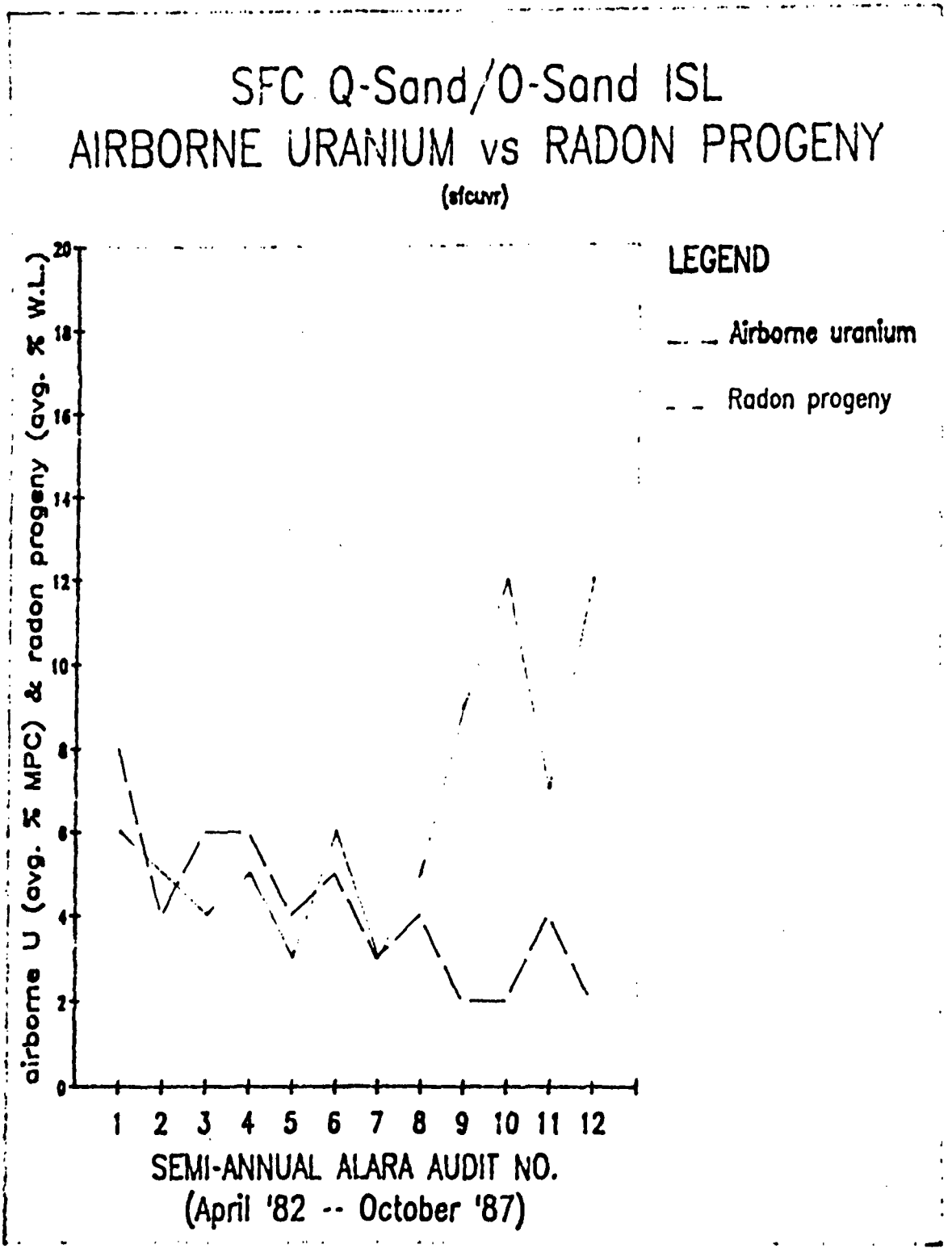


Figure 4.2.03 - Airborne Uranium versus Radon Progeny

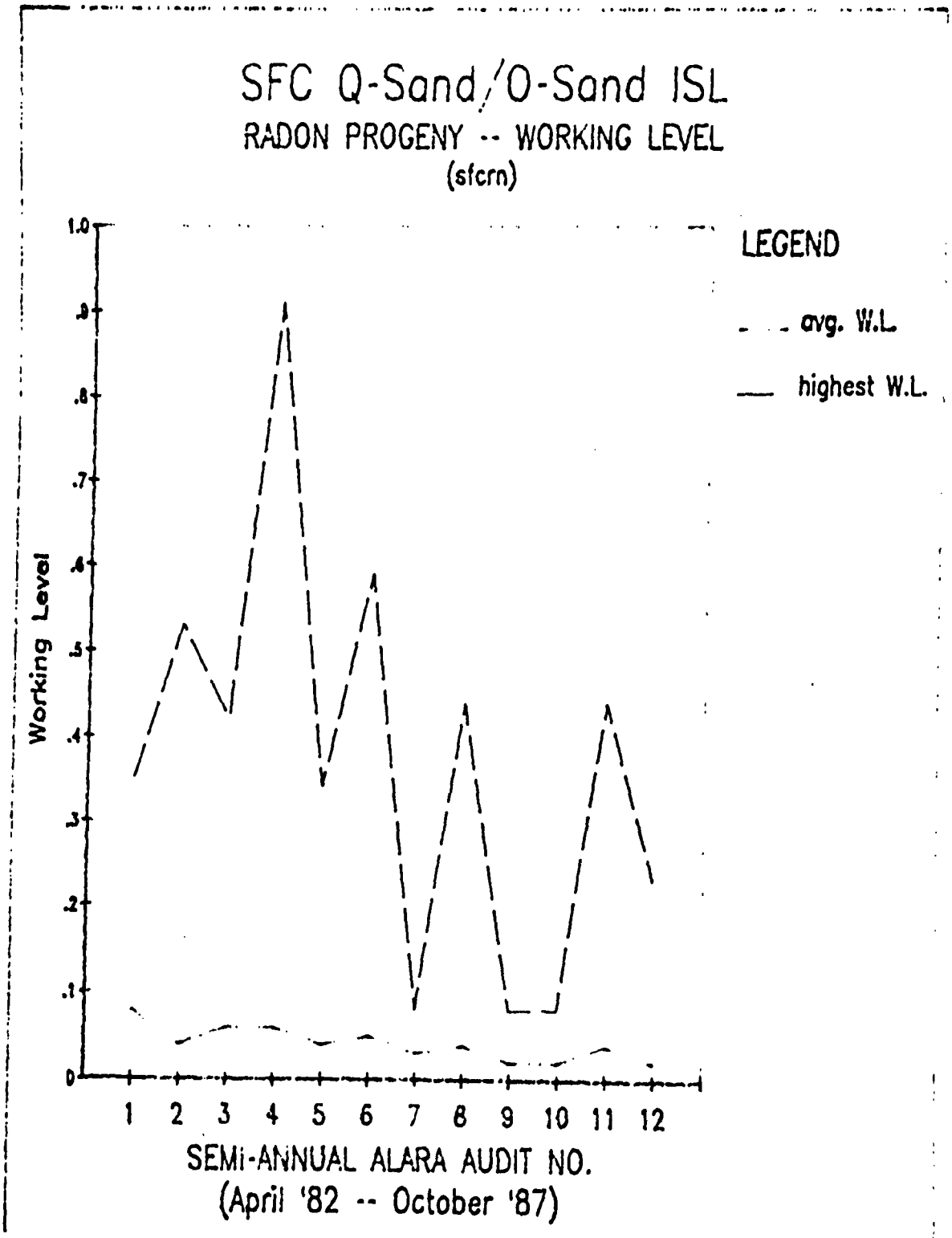


Figure 4.2.04 - Radon Progeny

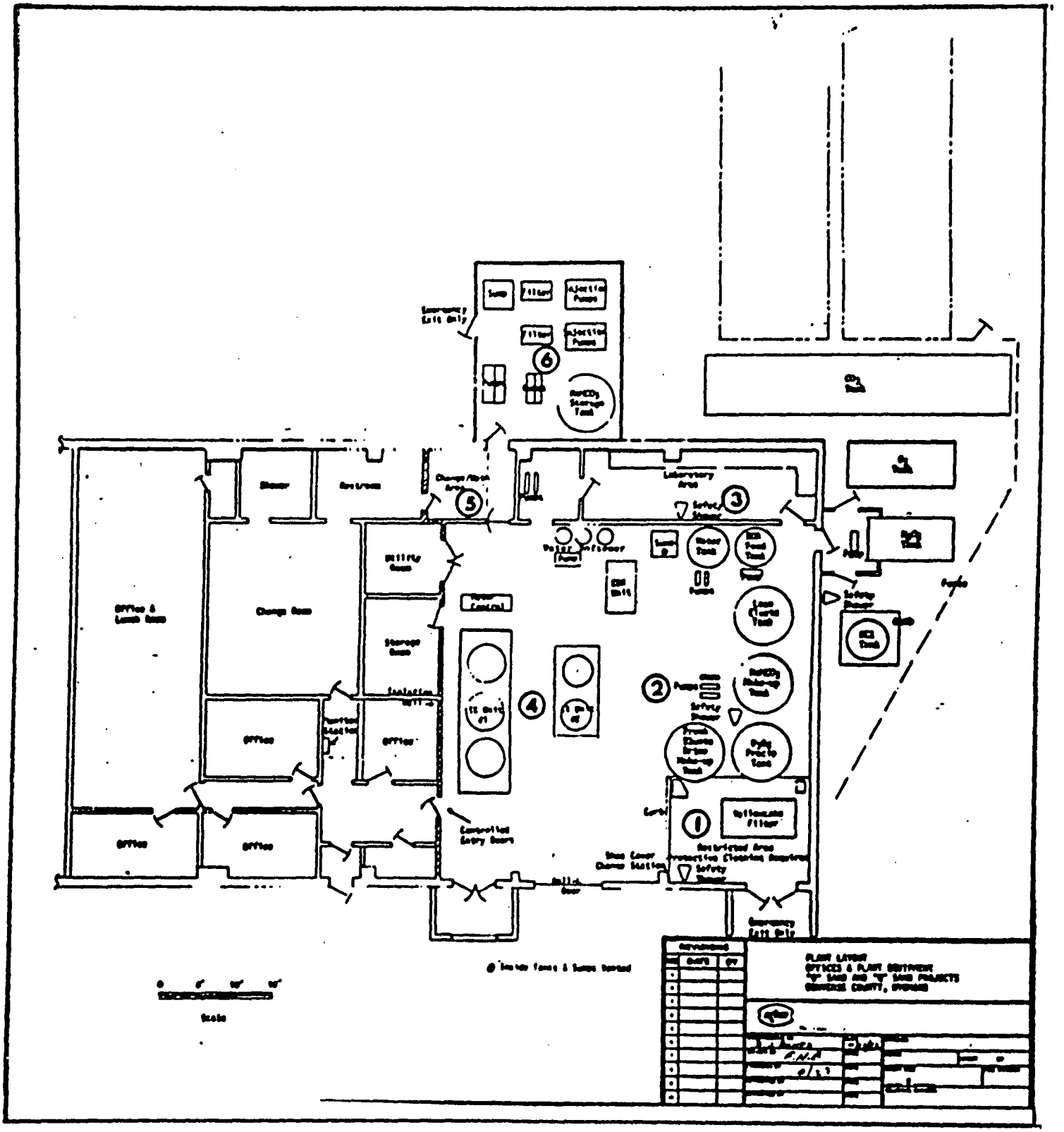

Figure 4.4.01 - Gamma Radiation Survey Locations.

Contamination Survey Frequency

- Restricted Controlled Area-End of Work Shift Involving Yellowcake
- Other Controlled Areas - biweekly
- Laboratory and Offices - monthly
- Eating and change area - weekly

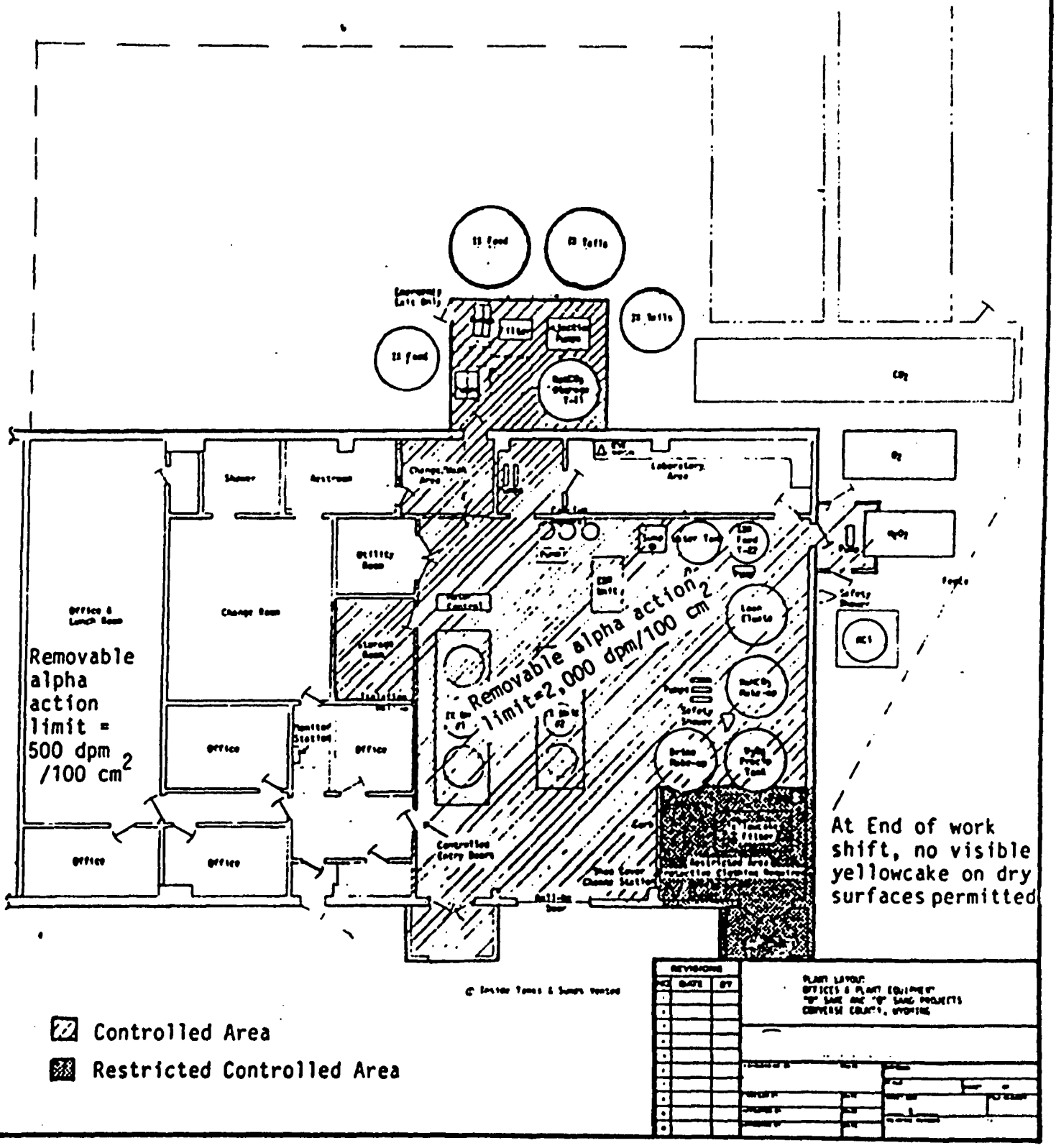


Figure 4.7.01 - Alpha Contamination Survey Locations.

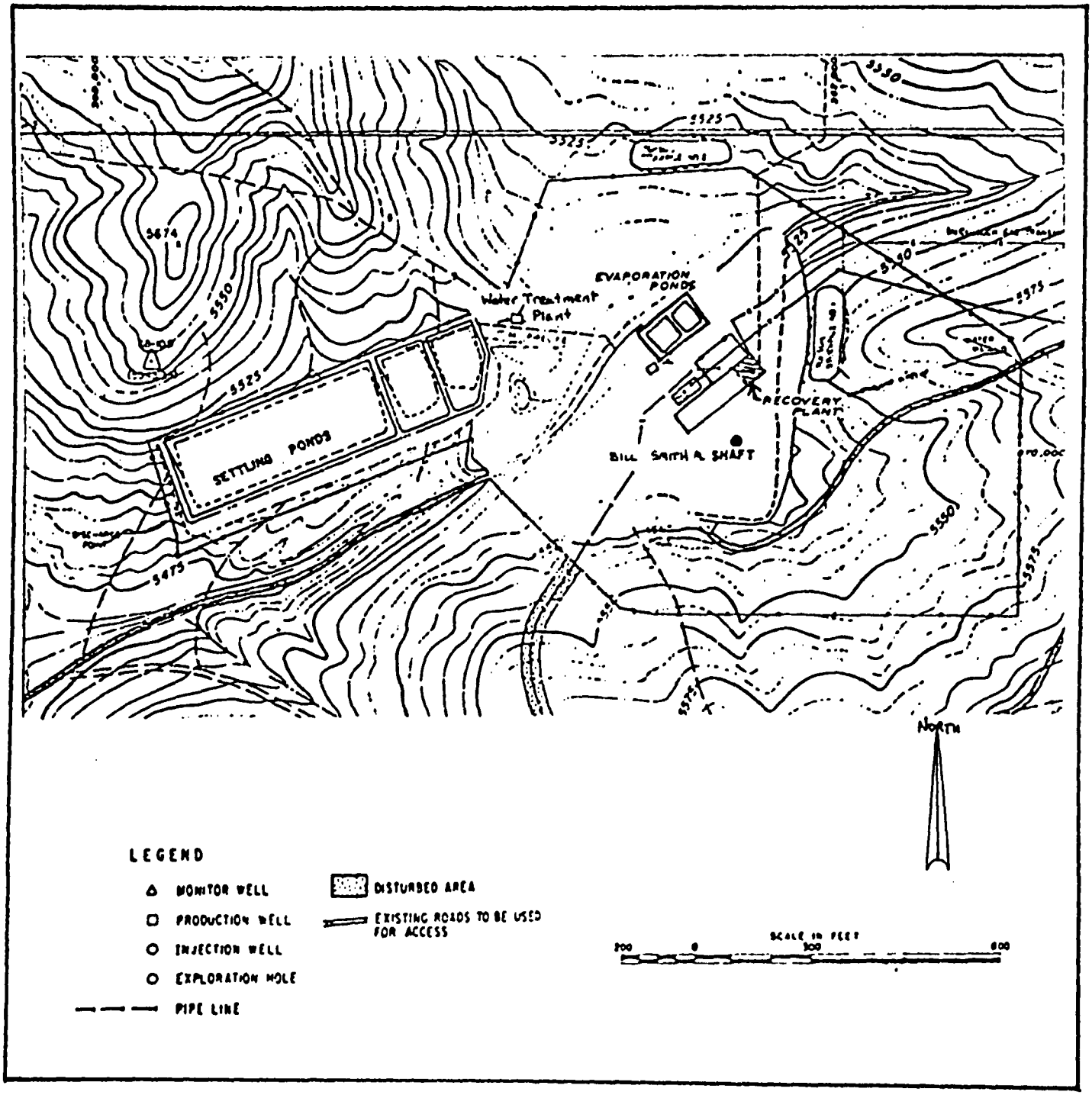


Figure 5.1.01 - Locations of Settling and Evaporation Ponds.