Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

June 27, 1996

Mr. William Edwards
International Institute of
Tropical Forestry
Call Box 25000
Rio Piedras, Puerto Rico, 00928-2500

Dear Mr. Edwards:

EL VERDE RESEARCH STATION CLOSE OUT ACTIVITIES

The following is the preliminary schedule of the remaining close out activities at El Verde Research Station:

July 1, 1996	Lead-based Paint Survey
July 8, 1996	Independent Environmental Safety and Health Inspection
July 15, 1996	Submit Lead-based paint survey report to USDA, Forest Service
August 9, 1996	Interagency Agreement to transfer funding to Forest Service for the fencing and warning signs at the Cs-137 contaminated area
August 15, 1996	Submit Independent Environmental Assessment to Forest Service
September 12, 1996	Facility walkthrough and inspection (DOE and USDA-ARS Officials)
September 18, 1996	Acceptance
September 24, 1996	Officially transfer El Verde facility to USDA Forest Service

Your assistance and cooperation to complete each one of the above-mentioned activities would be greatly appreciated.

1430.10

Please contact me at (423) 576-6821 or Mildred Ferre at (423) 576-8018 if you have any questions or need additional information.

Thanks for your support.

Sincerely,

Clayton S. Gist, Chief
Decontamination and
Decommissioning Branch

cc:
Cindy Hunter, AD-424
Jack Newman, 1009COM, MS-8230
Nancy Carnes, CC-10
Rachel Blumenfeld, CC-10

JOINT INSPECTION REPORT

ACTION: Department of Energy (DOE) transfer of the El Verde Research Station, including the DOE improvement thereon, and an approximately 80-acre site comprising the former DOE Ecological Study Area Site back to the custody of the Forest Service, U. S. Department of Agriculture. DOE obtained use of the site under the provisions of a 1964 Memorandum of Understanding between the USFS and the Atomic Energy Commission (AEC), and a 1976 Secondary Memorandum of Understanding between the USFS and the Energy Research and Development Administration (ERDA).

AGENCIES: U. S Department of Energy

Forest Service (USFS), U. S. Department of Agriculture

PREMISES: El Verde Research Station and Former Department of Energy Ecological Study Area

LOCATION: Located within the Luquillo Forest, also known as the Caribbean National Forest of Puerto Rico, approximately 15 km from the town of Luquillo and 35 km from the city of San Juan.

LAND: Approximately 80 acres

IMPROVEMENTS: Laboratory and Data Acquisition Center Building
Emergency Generator Building
Above-ground Diesel Storage Tank
Pole-mounted Transformer
Storage Building
Former USFS Facility (Converted to Dining Hall and Dormitory)

DISCUSSION ON ATTACHMENTS:

None

OBSERVATIONS AND DISCUSSION - JOINT INSPECTION:

On September 23, 1996, representatives of the USFS accompanied: Ms. Rachel Blumenfeld, Attorney, Office of Chief Counsel, DOE ORO; Dr. Clayton S. Gist, Chief, Decommissioning and Decontamination Branch, DOE ORO; Ms. Cindy B. Hunter, Realty Officer, Procurement and Contracts Division, DOE ORO; and Jack R. Newman, Realty Specialist, Lockheed Martin Energy Systems, Inc., on a joint inspection of the site and DOE-owned improvements. The USFS representatives found the site and improvements acceptable for transfer to the custody of the USFS. Although this inspection report was not signed by the USFS representatives participating in the inspection, they reported the findings to Mr. Pablo Cruz, Forest Supervisor, USDA-USFS International Institute of Tropical Forestry, at a meeting subsequent to the inspection. Based on the findings and USAF's satisfaction with DOE's environmental cleanup, decontamination, and restoration of the site, Mr. Cruz accepted the return of the site back to the custody of the USFS by signing Supplemental Agreement No. 1 to the Memorandum of Understanding that had authorized DOE use of the site. He also documented USAF's acceptance of the DOE-owned improvements on the site by signing the improvement transfer document (letter from DOE-ORO, dated September 23, 1996). The USFS agreed in the Supplemental Agreement to grant the DOE a new permit for the use of an approximately one-quarter acre parcel of land containing the Cesium-137 irradiated tree.

DATE: 9-23-96 Cindy Hunter

Cindy Hunter, Realty Officer
Department of Energy

Attachments:

1. Report No. ORISE 96/H4 "Phase I Environmental Site Assessment of the El Verde Research Station - Luquillo, Puerto Rico," dated September 1996.

2. ORAU Radiological Evaluation - Study Area 4, El Verde Research Station, Luquillo Forest, Luquillo, Puerto Rico, dated February 23, 1994.

3. Report No. ORNL/RASA-90/1 "Preliminary Site Survey Report of the El Verde Research Station, Center for Energy and Environmental Research, in the Luquillo Forest, Luquillo, Puerto Rico (PRE001).

4. Asbestos Inspection Report for the Center for Energy and Environment Research Facilities at El Verde, Puerto Rico, dated October 1994.

5. Report No. CEER-X-115 "Radiological Survey Report for El Verde Research Station Center for Energy and Environment Research , dated November, 1981 - Revised May, 1983.

6. Analysis for Polychlorinated Byphenils - Transformer Located at the El Verde Research Station Site in San Lorenzo, Puerto Rico.

7. ORAU Report - Radiological Measurements - Study Area 4, El Verde Research Station, Luquillo Forest, Luquillo, Puerto Rico, dated May 10, 1993.

8. DAC Environmental of Puerto Rico Report "Lead-based Paint Inspection for the El Verde CEER Facility, San Lorenza, Puerto Rico", dated July 1996.

Verde

Administración
Central
Universidad de
Puerto Rico

November 18, 1992

Mrs. Sandra Waldrom
Radiation Specialist
US Nuclear Regulatory Commission
Region II
Suite 2900
101 Marietta Street, N.W.
Atlanta, GA 30323

Oficina de
Planificación y
Desarrollo

Calidad Ambiental y
Seguridad
Ocupacional

Dear Mrs. Waldrom

As per your request, this is to inform that, at present, there is no radioative material, other than the residues of CS-127 inyected in two trees, at the **El Verde Research Station.**

These trees are located in the forest, see figure enclosed. The area is fenced in a radius 6 feet from them, and is not accesible to the general public.

The Gas Chromatograph identified in the license was sent back to the US when the person involved in research using it, went back to the university of origin.

The 700 mci of tritium were transferred to UPR, Mayaguez Campus under my custody. We feel this is a safer storage site.

If you need additional information, please let me know.

Sincerely,

Nimia E. Irizarry
Radiation Safety Officer

C: Dr. Robert Waide
Prof. Onelio Núñez Méndez

[redacted]
Apartado 5262
Estación Colegio
Recinto Universitario
de Mayagüez
Mayagüez, Puerto Rico
00709
(809) 832-1405
Fax (809) 834-8025

4 NOV 96 4:36

FORM NRC-313 I (1-79) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

- XX a. NEW LICENSE
- b. AMENDMENT TO: LICENSE NUMBER
- c. RENEWAL OF: LICENSE NUMBER L 19434

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*
Center for Energy and Environment Research

TELEPHONE NUMBER AREA CODE – NUMBER EXTENSION
(809) 765-7210

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
Ms. Nimia E. Irizarry

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(809) 832-1405

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*
Center for Energy and Environment Rese.
Caparra Heights Station
San Juan, Puerto Rico 00935
Atention: Ms. Nimia E. Irizarry

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*
Caribean National Forest
El Verde Rain Forest
Mailing Address same as Item 4.

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Jeffrey Carl Luvall	
b.		
c.		

7. RADIATION PROTECTION OFFICER
Nimia E. Irizarry

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.
See resume attached.

8. LICENSED MATERIAL

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)*	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
(1)	H-3	Liquid		(4 Ci) 4000 mCi
(2)	Cs- 137	Liquid		1 milliCurie
(3)				
(4)				

	E DESCRIBE USE OF LICENSED MATERIAL
(1)	See method attached
(2)	
(3)	
(4)	

FORM NRC-313 I (1-79)

10.7-11

596

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	N/A		
(2)			
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED (alpha, beta, gamma, neutron) E	SENSITIVITY RANGE (milliroentgens/hour or counts/minute) F
(1)	See attached	list				
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

☒ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE (Check and/or complete as appropriate.) A	SUPPLIER (Service Company) B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER (TLD) N/A ☐ (3) OTHER (Specify): _____		☐ MONTHLY ☐ QUARTERLY ☐ OTHER (Specify): _____

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☒ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS (Include filtration, if any), ETC.
☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING (fixed and/or temporary), ETC.
☐ c REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.
☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

FORM NRC 313 I (1-79)

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.—18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)* Juan A. Bonnet, Jr.
	c. NAME *(Type or print)* Juan Bonnet, Jr.
(1) LICENSE FEE CATEGORY:	d. TITLE Director, CEER
(2) LICENSE FEE ENCLOSED: $	e. DATE

FORM NRC-313 I (1-79)

10 7-13

CSEOS

Form NRC-313 I

Item 8E
Describe the use of Licensed Material

METHOD FOR THE USE OF TRITIUM

Transpiration rates of some trees at El Verde Rain Forest will be estimated using the HTO method. Three trees will receive a total of 3 ml of HTO (21 mCi/tree total) volumetrically pipetted into the trunk, at a 45° angle, about 25 cm above the ground. Each hole then, will be sealed with tree grafting compound.

Three clear polyethylene bags will be used to collect moisture in each tree. A bag will cover one branch tip selected in the lower, middle and upper crown of each tree. Approximately 25 cm of the branch tips,will be sealed in each bag with duct tape. An additional nearby tree will be similarly bagged to monitor background HTO levels. Once a day, condensed moisture will be carefully shaken from the sides of each bag and withdrawn by syringe. The syringe hole in the bag will be sealed and the water deposited in glass vials. A new syringe will be used for each bag and sampling to prevent cross-contamination; however, the original bag and branch will be utilized for the entire sampling period. HTO activity in sample water will be determined using standard liquid scintillation counting procedures.

One tree will be harvest at the end of the experiment to determine residue HTO concentrations in the leaves, brwnches and hole.

NOTE:

This procedure could be modified as the experiment takes place. No modification will be made without previous approval from the Radiation Safety Supervisor.

USE OF CS- 137

Cs-137 will not be bought nor used at the present time. The reason for including it in the License is that two trees were inoculated on September 18, 1968, a tree in the forest was inoculated with 0.46 mCi of Cs-137 and although

Cont. Item 8E

Describe the use of Licensed Material

more than 50% of the cesium has been eliminated, the remaining isotope causes radiation levels of 200 µR/hr in an area where the background level is 5 µR/hr. This experiment was carried out under the spossorship of the Department of Energy (formerly ERDA and Atomic Energy Commission) and no special license was required. The area is isolated by means of a wire fence and radiation safety signs have been placed.

Form NRC-313 I
Item 10
Radiation Detection Instruments

Type of Instrument	Manufacturer's Name	Model Nunber	Number Available	Radiation Detected	Sensitivity Range
Teletector (GM)	Eberline Instr. Corp.	6112	4	$\beta\gamma$	0 - 5R/hr
Ludlum Geiger Counter	Ludlum Measurements, Inc.	2 and 3	4	$\beta\gamma$	0 - 500K cpm
Ludlum Geiger Counter	Ludlum Measurements, Inc.	3	1	$\beta\gamma$	0 - 200mR/hr
Ludlum Geiger Counter	Ludlum Measurements, Inc.	2	2	α	0 - 500K cpm
Vamp air monitor	Victoreen	808 B	4	$\beta\gamma$	0.1 - 100mR/hr
Gas Flow Proportional Counter	Nuclear Measuremants Corp.	PCC-11T-DS -1T Comb.	2	$\alpha\ \beta\ \gamma$	
GeLi Spectrometer	Camberra Ind.	7229	1	γ	
Scintillation Survey Monitor	Reactor Control Div.	NE 148A	2	γ	1µR/hr -300 µR/hr

Form NRC-313 I
Item 11
Calibration of Instruments listed in Item 10

GAS FLOW PROPORTIONAL COUNTER

The Gas Flow Proportional Counters' plateaus and operational voltage are checked every three months using Ra D&E calibration sources manufactured by Nuclear Measurements Corp. for this type of instruments.

The amounts of HTO that will be used and the low beta energy of the Tritium, makes it improbable that contamination, if any occurs, be detected using portable survey meters. For this reason the weekly surveys will rely mainly in the smear technique and the Gas Flow Proportional counting.

Form NRC- 313 I
Item 13
Facilities and Equipment

Tritium and Cs-137 will be used in the El Verde Rain Forest located in the Caribbean National Forest - Luquillo Forest. Figure 1 is a schematic of El Verde Research Station and its location in the Island of Puerto Rico. The detail of the Research Station is Figure 2 and a detail of the laboratory where the isotopes will be used is Figure 3.

Laboratory 11 where the isotopes will be handled, is equipped with a hood and two benches for isotope handling. HTO will be prepared in this lab. and transported to the forest in safe containers.

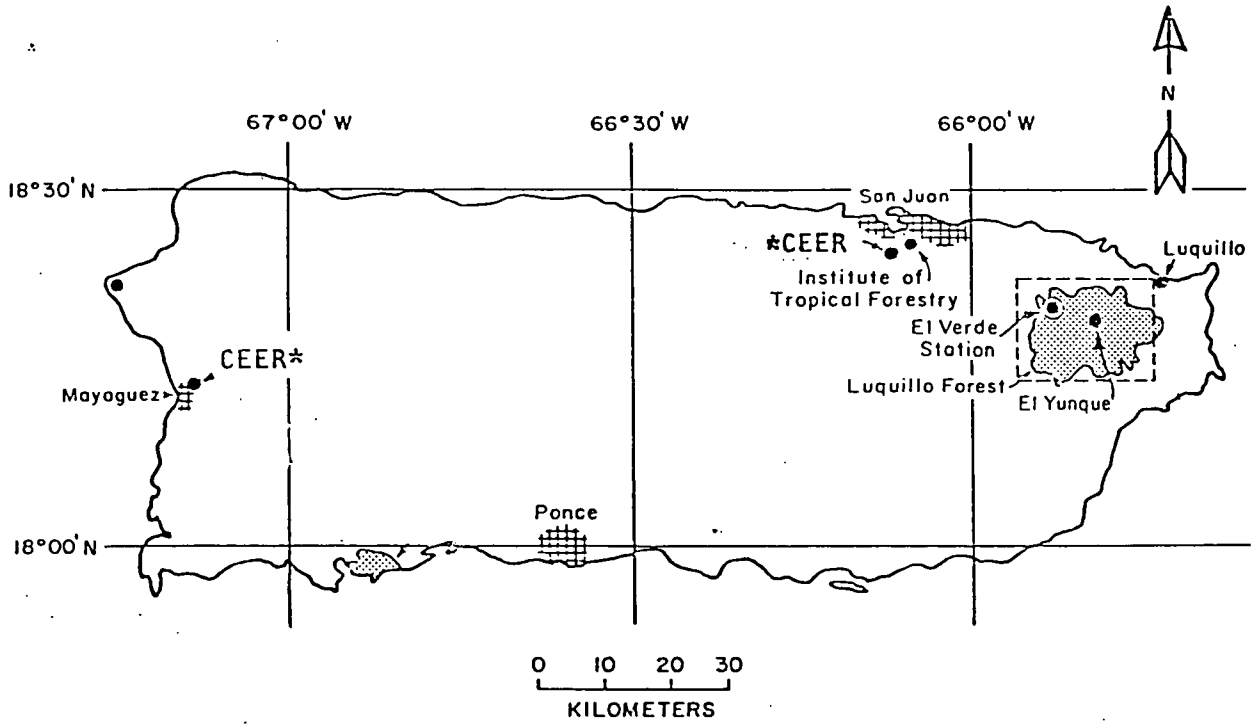
Protective Equipment

Gloves and lab. coats or aprons will be used while handling the isotopes.

Storage Facilities

Tritium will be stored in laboratory 11 (Fig. 3) in safe containers. No special shielding is required.

Form NRC-313 I
Item 13
Facilities and Equipment

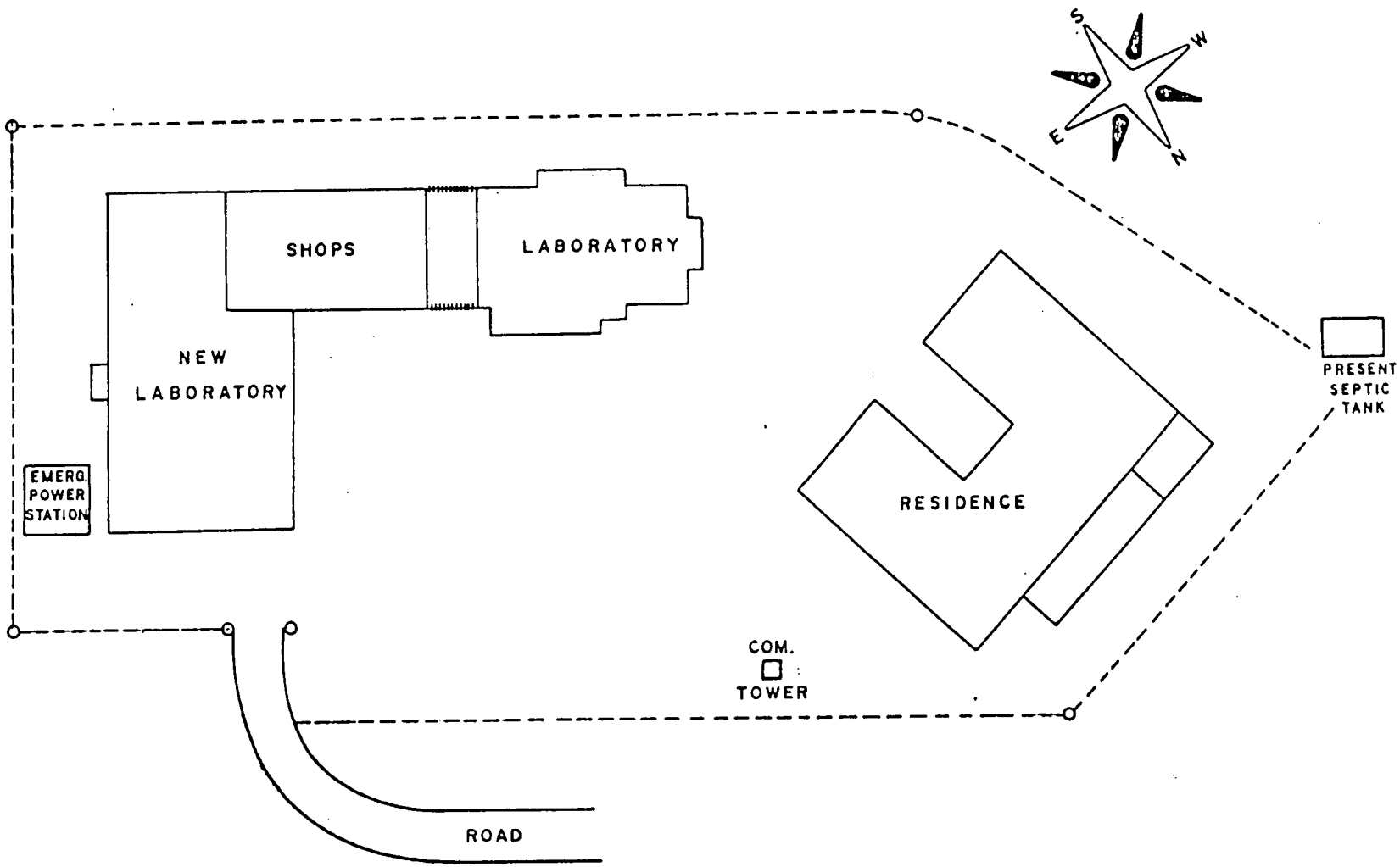


* Center for Energy and Environment Research's facilities

Figure 1. Location of El Verde Research Station in the Island of Puerto Rico Other CEER facilities are marked for refference.

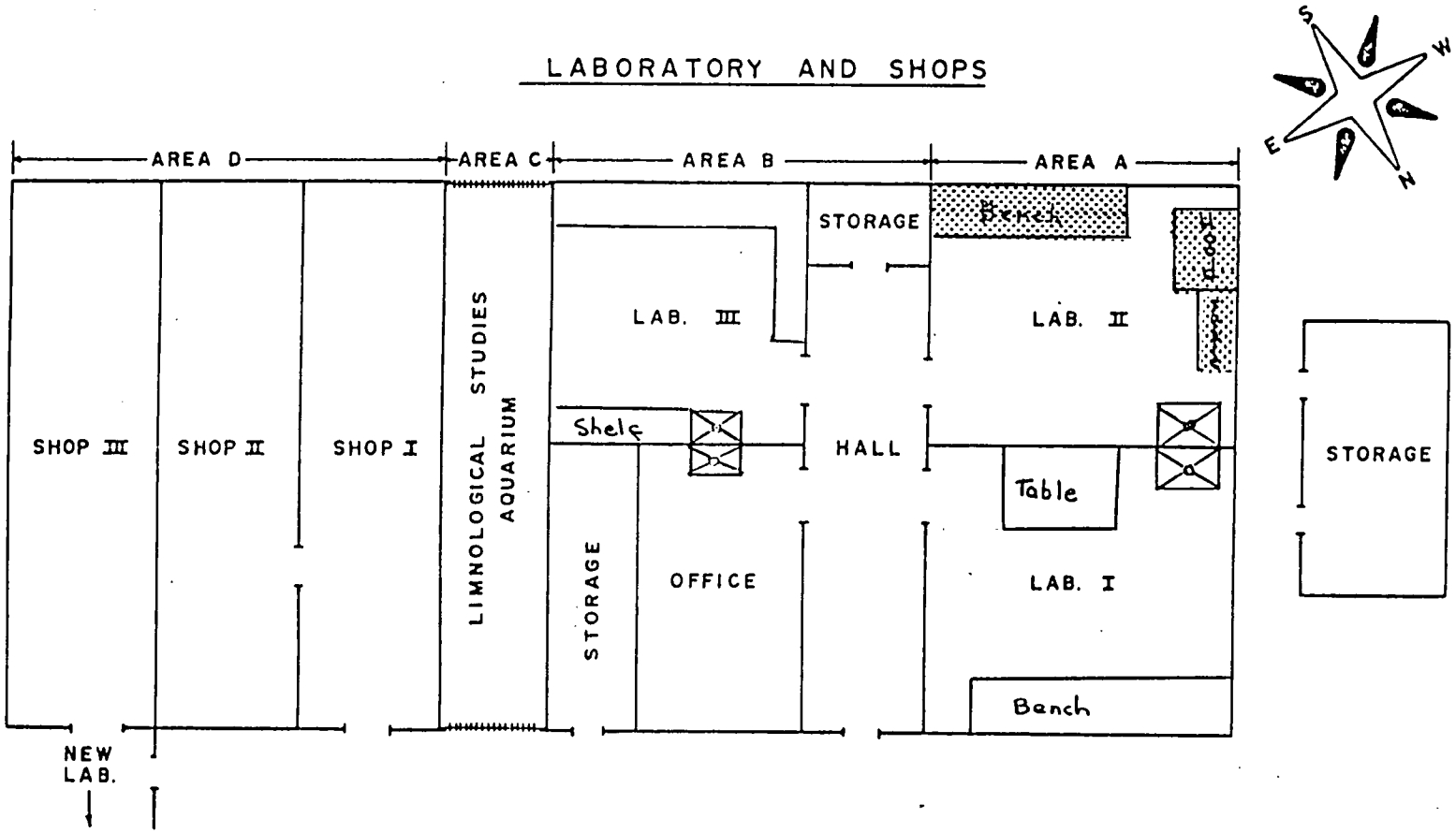
Form NRC-313 I
Item 13
Facilities and Equipment

Figure 2. Detail of El Verde Research Station



Form NRC-313 I
Item 13
Facilities and Equipment

Figure 3. Detail of the Laboratory area where ^{3}H will be handled.



--- Laboratory where ^{3}H will be handled and stored.

Form NRC-313 I
Item 14
Waste Disposal

Liquid Scintillation Wastes

Liquid Scintillation wastes will be disposed of acording to 10 CFR 20.306.

1. 0.05 µCi of ^{3}H per gram of medium for LSC will be disposed though the sanitary sewage.
2. Higher concentrations will be diluted in order to reach the concentration mentioned in 1 above.

Solid Wastes

1. Low level solid wastes consisting of waste absorbent paper, contaminated leaves and tree pieces will be incinerated in the incinerator of the Medical Sciences Campus of the University of Puerto Rico (license number 52-01946-07). The incineration will be done under the supervision of the Radiation Protection Supervisor of the quoted license and CEER's.

Form NRC-313 I
Item 15
Radiation Protection Program

RESPONSIBILITIES

Director CEER

The Director of the Center for Energy and Environment Research has the ultimate responsibility and authority for all activities related to Radiation Safety. The Director CEER will issue, under competent advice, regulations governing the use of radiactive materials at CEER's El Verde Research Station.specifically in the areas under CEER's control.

Radiation Safety Supervisor (Radiation Protection Officer)

Responsibilities:

1. The Radiation Safety Supervisor (RSS or RPO) has operational responsibility for all maters related to the safe use of radioisotopes.
2. Is responsible for conducting the Radiation Safety Program within CEER.
3. Has full authority to stop, without consultation, any procedure deemed unsafe.
4. Represents the Director in all maters related to radiation safety.
5. Can authorize repeats of experiments previously approved by NRC.

Duties

1. The general surveillance of all activities pertaining to radiation safety including, but not limited to, use, acquisition and disposal of radioisotopes and radiactive wastes.
2. Receiving, opening, delivering, supervising storage, disposal and tranfer of radioactive materials arriving CEER.

Cont. Duties - RPO

3. Performing periodical surveys in all areas where radioisotopes area being used.
4. Maintaining an inventory of all radioisotopes under CEER's control.
5. Supervising decontamination procedures in cases of accidents involving radioisotopes.
6. Enforcing all NRC and local authority applicable ragulations.
7. Maintaining all required records and forms.
8. Other duties as the case requires.

Person Using radioisotopes

Responsibilities:

1. Use radioisotopes in such a manner as to minimize all chances of undue contamination.
2. Properly label radioactive materials and materials that have been used with them.
3. Keeping areas where radioisotopes are being used, clean and safe.
4. Refraining from smoking, eating or using cosmetics in any place where radioisotopes are handled.
5. Never, under any circumstances, pipetting any radioactive solution by mouth.
6. Wearing protective clothing and equipment appropriate for the task being carried out.
7. The custody of the radiactive materials under his (her) responsibili These materials shall not be loaned, given or otherwise transfe-- rred without prior approval by the RPO.

Cont. Responsibilities - Person Using Radioisotopes

8. Reporting promptly to the RPO any accident or spill involving radioactive material.
9. Taking prompt action to prevent the spread of any released or spilled radiactive materials.
10. Carrying out decontamination procedures, under the direction of the RPO.
11. Never, under any circumstances, working with radioisotopes while having an exposed wound.
12. Prior to separation, leaving the working area in a clean, safe and neat condition.
13. Making use of those techniques that will prevent a spill or other accident.

Supervisory Personnel

Supervisory personnel shall insure that individuals under their direction handle radiactive materials in a safe manner and shall further be responsible for:

1. Adequate planning of procedures and experiments involving the use of radioactive materials.
2. Notifying the RPO at least four (4) weeks in advance of any new experiments or procedures involving the use of radioisotopes.
3. Procuring, using and disposing of radioactive materials in accordance with these regulations.
4. Obtaining clearance from the RPO before any equipment that may be contaminated, is sent out of the working area for cleaning, repair, or modification, to surplus or to ultimate disposal.

Cont. Responsibilities - Supervisory Personnel

5. Notifying the RPO of any accidents involving radioisotopes within their responsibility.
6. Obtaining approval from the RPO for the procurement of radioactive materials.
7. Instructing personnel under their responsibility in the techniques necessary to maximize safety.

From NRC-313 I
Item 15
Radiation Protection Program

Acquisition and Use of Radioactive Materials

The following procedures are to be followed in the acquisition and use of any radioactive material. In developing these procedures every attempt has been made to achieve simplicity, while at the same time complying with all applicable regulations and requirements of radiation safety.

I. Authorization of Experiments and Operations

1. All experiments and operations involving the use of radioisotopes within El Verde shall have a prior written approval from the Radiation Safety Officer.

2. All experiments proposed will be submitted to the RPO using HPO FORM-004 within no less than four weeks prior to expected date that the experiment will start.

3. The RPO will review all proposals as soon as possible and shall notify the results to the requisitioner using the space provided in HPO FORM-004.

4. Experiments that will be a repetition of a previously approved one, also need approval from the Radiation Protection Officer.

5. The requisitioner is responsible for providing to the RPO all the information, related to the experiment being revised, that the RPO considers necessary for a better evaluation of it.

II. Radioactive Material from Outside the Center: Purchasing

Only those individuals who have been approved by the RPO are permitted to acquire, by whatever means, radioactive materials from outside the El Verde. A request for procurement is initiated by submitting two copies of HPO FORM-001 to the Radiation Protection Officer. If the application is approved, the Radiation Protection Officer will return one copy of it bearing an approval number. This number, valid for the current fiscal year, will

authorize the procurement of the listed radioisotopes in the amount, form, and for the use specified in the application. If the proposed acquisition or use is unacceptable from a safety standpoint, the Radiation Protection Officer will consult promptly with the originator to determine the modifications needed in order to satisfy safety requirements. When an approved user desires to acquire radioactive material as specified on approved HPO FORM -001, he will submit to the Radiation Protection Officer HPO FORM-002 in triplicate, together with the standard CEER purchase requisition form. When the request is approved the Radiation Protection Officer will:

a. Return one approved copy of HPO FORM-002 to the requisitioner.

b. Note approval on the purchase requisition and one copy of HPO FORM-002 and forward it through the corresponding administrative channels to the Procurement Office for processing. The Procurement Office will not initiate procurement of any radioactive material without this approval.

All incoming radioactive materials shall be delivered to the Radiation Protection Officer. Upon receipt of a shipment, the Radiation Protection Officer will:

a. Verify the contents of the package (Compare requisition, packing slips and label on bottles).

b. Proceed to open the package wearing gloves.

c. Check the package, the packing material and the inner containers for surface contamination, breakage, loss of liquid or discoloration of packing material.

d. Where possible, make at least a rough check on the activity received.

e. Fill the corresponding blanks in the HPO-FORM 002.

f. If acceptable, deliver the material promptly to the requisitioner.

g. If packing material is not contaminated eliminate the labels and dispose of as regular trash.

NOTE: No packages are delivered to the Center during off-duty hours.

III. Radioisotopes Transfer

DOT regulations control the transport of radioactive materials. No transfer of radioactive material by air or land must be made without the supervision and approval of the Radiation Protection Officer.

Form NRC-313 I
Item 15
Radiation Protectic Procedures

Radioactive Materials Handling

A. Designation of Areas

1. The laboratory described in Item 13 will be considered restricted area.
2. All radioactive H-3 will be handled and/or stored in laboratory II.
3. This area will be marked with signs bearing the radiation symbols as specified in 10 CFR and the words in English and/or Spanish:
   CAUTION: RADIOACTIVE MATERIAL or PELIGRO: MATERIALES RADICACTIVOS

B. Laboratory Practice

It is not possible to present in detail all of the techniques and procedures applicable to the proper use of radioactive materials. Some of the most important requirements are given below. The Radiation Protection Officer and/or the Radiation Safety Committee will review special cases and will supply detailed information upon request:

a. Each entrance into an area where radioactive materials are used or stored in such a manner as to make that area a restricted area will be conspicuously marked.
b. Containers in which radioactive materials are being stored or transported shall be appropriately marked with labels or decals available from the Radiation Protection Officer. Each label or decal shall identify the nuclide, give the activity within the container, the date of the activity estimate, and the initials of the responsible custodian. This labeling shall not be required for laboratory containers such as beakers and flasks being used in laboratory procedures during the presence of the user.
c. Stock solutions or sources in use may be kept in the laboratory area in a safe container properly shielded.
d. Manipulations involving radioactive materials shall be carried out inside hoods as far as is practicable.

e. As extensive use as possible should be made of protective devices such as trays, glass plates, or absorbent paper in order to prevent contamination of permanent building structures such as bench tops, hoods, and floors. Absorbent paper should be discarded frequently to prevent the dusting off of spills that have dried.

f. Each user of radioactive nuclides shall make periodic surveys of his area to search for contamination.

g. Equipment used with radioactive nuclides shall not be released to other workers, sent to a shop for repairs or modifications, or to surplus, and shall not be discarded until it is demonstrated by the Radiation Protection Officer to be free of contamination. Repairs or modifications that must be made on contaminated equipment shall be done under the supervision of the Radiation Protection Officer.

h. No maintenance work or repair shall be made on any laboratory sink traps or waste lines or on any hood ducts, exhaust systems, or house vacuum lines until the areas involved have been cleared by the Radiation Protection Officer.

i. Protective gloves of surgical rubber or disposable plastic and lab coats should be worn when working with radioactive materials.

j. Protective equipment such as laboratory coats, surgical or disposable gloves etc., should not be worn outside the laboratories or working area.

k. Mechanical pipette-filling devices shall always be used with radioactive solutions. Never use the mouth to pipette radioactive solutions.

l. Smoking, eating, drinking, and use of cosmetics are forbidden in areas where radioactive nuclides are used.

m. Liquid radioactive wastes shall not be put into the regular laboratory sewerage system unless they are known to conform to the requirements specified by the Radiation Protection Officer.

C. Decontamination Practice

1. Equipment Decontamination

When equipment has been contaminated, a decision must be made as to whether it is most advantageous to discard, set aside for decay, or to decontaminate. If to be discarded such equipment shall be considered as radioactive waste and shall be turned over to the Health and Safety Division for disposal. The Health and Safety Division will also assist in storing equipment during decay to usable levels.

It is usually advantageous to start decontamination procedures promptly. Delay frequently fixes the contaminants more firmly onto surfaces. During contamination procedures protective gloves shall always be worn, supplemented by protective clothing if it is indicated.

In general, the user can choose the most effective decontamination procedure from a knowledge of the properties of the contaminant. The Radiation Protection Officer will provide advice, materials and assistance in refractory cases, and will supervise disposal of the cleaning materials.

2. Personnel Decontamination

When radioactive nuclides come in contact with the skin the radiation dose-rate at the contaminated area may be very high. In addition, many contaminants are in form that are readily absorbed through the intact skin, and, to a much greater extent, through cuts and abrasions. Any contaminating event must be considered to create a situation requiring prompt attention. Whenever there has been any personal contamination, the Radiation Protection Officer should be called at once to assist in the decontamination. When large areas of the body are involved, showering may be required.

Form NRC-313 I
Item 15
Radiation Protection Procedures

Without waiting for Health and Safety Division assistance to arrive, start washing procedures at once. Wash thoroughly using any available soap or detergent. Washing should be vigorous but care should be taken not to injure the skin by too-harsh treatment. A soft bristle brush may be effective. Recheck at intervals with a survey meter to note any improvement. If progress is being made the washings should be repeated again and again. If progress is negligible, a chelating agent such as EDTA (versene) may be used in place of the soap. The Radiation Protection Officer maintains supplies of appropriate agents. If contamination persists, the Radiation Protection Officer may call a physician to direct the use of more drastic cleansing agents.

The decontamination of wounds and skin abrasions should also be carried out under the direction of a physician. When the skin is injured, an important barrier to the entry of contaminants is lost and mismanagement of cleansing procedures can do more harm than good.

If several vigorous washings do not sharply reduce the contamination of body hair, it should be cut short, using extreme care not to injure the intact skin. Removal of the hair will permit more effective treatment of the underlying skin.

Form NRC-313 I
Item 15
Radiation Protection I cedures

EMERGENCY PROCEDURES

1. Radioactive Material Spills.

Minor Spills:

1. NOTIFY: Notify persons in the area that a spill has occurred.
2. PREVENT THE SPREAD: Cover the spill with absorbent paper.
3. CLEAN UP: Use disposable gloves and remote handling tongs. Carefully fold the absorbent paper and pad. Insert into a plastic bag and dispose of in the radioactive waste container. Include all other contaminated materials such as disposable gloves.
4. SURVEY: With a G.M. Survey Meter, check the area around the spill, your hands and clothing for contamination.
5. REPORT: Report incident to the Radiation Safety Officer.

Major Spills:

1. CLEAR THE AREA: Notify all persons not involved in the spill to vacate the room.
2. PREVENT THE SPREAD: Cover the spill with absorbent pads, but do not attempt to clear it up. Confine the movement of all personnel potentially contaminated to prevent the spread.
3. SHIELD THE SOURCE: If possible, the spill should be shielded but only if it can be done without further contamination or without significantly increasing your radiation exposure.
4. CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry.
5. CALL FOR HELP: Notify the Radiation Safety Officer immediately.
6. PERSONNEL DECONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Officer. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.

RADIATION SAFETY OFFICER: _____

OFFICE PHONE: _____

HOME PHONE: _____

Form NRC-313 1
Item 15
Contamination Level

Methods and Frequency of Surveys

1. Direct Survey:

   Due to the low activity of the samples to be handled it is considered that in the majority of the surveys more emphasis will be given to the surveys for removable contamination explained below. However, a survey meter sufficiently sensitive to detect 0.1 mr/hr will be used whenever a direct survey is carried out.

2. Survey for Removable Contamination:

   Standard smear techniques, i.e. wiping a surface of 100 cm^2 with a filter paper, using moderate pressure and then counting the activity of the filter paper in an appropriate instrument will be used in the survey for removable contamination.. The method for performing wipe tests will be sufficiently sensitive to detect 100 dpm.

   A liquid scintillation counter will be used for counting the smears taken in those areas where H-3 has been used. A permanent record using the following forms will be kept of survey results.

   FORMS: HEALTH PHYSICS ASSAY REPORT, HEALTH PHYSICS MONITORING REPORT.

Acceptable Limits

1. Radiation Levels:

   The principle of maintaining radiation exposures as low as practicable and within the guidelines provided in 10 CFR Part 20.101 will be followed at the Center.

   No radiation worker may receive more than 2.5 mR/h or more than 100 mR in five consecutive working days or 5000 mR in any one calendar year.

2. Contamination Limits:

   a. Specific cleanup is required in any area where a wipe test shows 200 dpm above background.

   b. A level above 1000 dpm defines a contamination zone which will be specially restricted until decontamination is accomplished and released by the Radiation Protection Officer.

Form NRC-313 I
Item 15
Contamination Levels

3. Frequency of Surveys:

Laboratory areas where only small quantities of radioactive material are used (less than 100 μCi) will be surveyed monthly. All other areas will be surveyed weekly.

Form NRC-313 I
Item 15
Bioassay Procedures

Because of the amounts of Tritium to be handled and the lack of survey meters capable of detecting those levels, it is considered necesary to do bioassay as a monitoring technique. Standard urinalisys method will be used.

Person performing the bioassay:

Santiago Gomez - Health Phisicist

Experience doing urinalysis

3 years.

Frequency of urinalisys

It will be made at the begining of the experiments,the first two weeks and then monthly or every three months if the results show any abnormal results.

Place where urinalysis will be made:

Medical Sciences Campus - University of Puerto Rico

PERSONAL RESUME
OF
JEFFREY CARL LUVALL

PERSENT ADDRESS:
Institute of Ecology
University of Georgia
Athens, GA
404 542-2968

PERMANENT ADDRESS:
RR # 2 Stillwood
Galesburg, IL 61401
309 343-2273

EDUCATION:

Master of Science, Specializing in Forest Ecology. May 1977, Southern Illinois University

Bachelor of Science, Specializing in Forest Resource Management. May 1975, Southern Illinois University.

WORK EXPERIENCE:

SEPTEMBER 1979 - MARCH 1980
Part-time faculty, Augusta College,
Teaching two-quarter sequence introductory biology with lab.

FEBRUARY 1979 - MARCH 1979
Part-time faculty, Paine College, Augusta, GA
Teaching an introductory botany course.

AUGUST 1978 - DECEMBER 1978
Part-time faculty, University of South Carolina, Aiken campus. Teaching an introductory botany course.

NOVEMBER 1976 - PRESENT
Research Tech III, Savannah River Ecology Laboratory, Aiken, S. C.
Research:
(1) Nutrient cycling in plant communities.
(2) Tritium storage patterns and movement in the ecosystem.
(3) Statistical analysis of data using multivariate procedures.
Undergraduate Research Program:
(1) Provide supervision and technical assistance.
(2) Conduct student field trips.
Public Relations:
(1) Conduct tours explaining current research in progress at the laboratory.
(2) Speak at various community organizations explaining the function of the laboratory.

WORK EXPERIENCE: (Cont'd)

JANUARY 1975 - NOVEMBER 1976
Graduate Research Assistant, Department of Forestry, Southern Illinois University.
Assisted Teaching:
(1) Wood Technology.
(2) Forest Ecology.
(3) Dendrology.
Research:
Nutrient cycling in Upland Oak-Hickory Forests. Supervised three student workers and laboratory work including the operation of the Forestry Department's Perkin-Elmer Model 360 Atomic Absorption Spectrophotometer.

SUMMER 1974
Kopper's Forest Products Division, Carbondale, Illinois. Supervised four men in identification of wood species and grading railroad ties.

SUMMER 1974 (part-time)
Carbondale Mosquito Abatement District, Carbondale, Illinois. Spraying and larviciding mosquito breeding areas.

JUNE 1973 - JUNE 1974
Department of Forestry, Southern Illinois University. Student worker. Assisted in field data collection and general laboratory work.

PUBLICATIONS:

Luvall, J. C. and G. T. Weaver. 1976. Sampling intensities required to estimate forest floor parameters in Southwestern Illinois. AG Review. Southern Illinois University. p. 65-67.

Luvall, J. C. 1977. The amount and distribution of biomass and mineral nutrients in forest floor horizons in Oak-Hickory and mixed hardwood forests in Southwestern Illinois. Unpublished M. S. Thesis. Department of Forestry, Southern Illinois University. 95 pp.

Sharitz, R. R. and J. C. Luvall. 1978. Growth of duckweed under contant and variable temperatures. In Energy and Environmental Stress in Aquatic Systems Symposium. J. H. Thorp and J. W. Gibbons eds. DOE Symposium Series 48. CONF-771114.

Luvall, J. C. and G. T. Weaver. 1978. Variability in forest floor components in Southwestern Illinois Upland forests. Central Hardwood Forest Conference Proceedings II. P. E. Pope (ed.), Purdue University.

PUBLICATIONS: (Cont'd)	Luvall, J. C. and C. E. Murphy, Jr. 1981. Evaluation of the tritiated water method for measurement of transpiration in young Pinus taeda L. Forest Science (in press).
PROFESSIONAL ORGANIZATIONS:	Association of Southeastern Biologist Society of American Foresters Xi Sigma Pi Honarary Forestry Society
AWARDS:	Association of Southeastern Biologists Research Award for 1980. Sigma Xi The Scientific Research Society of North America Grant-in-Aid of Research. Association of Southeastern Biologists Travel Award 1976. Finalist Herb Oetjen Award for outstanding School of Agriculture student 1974.
PERSONAL DATA:	AGE 26. Ht. 1.75M. Wt. 71.7Kg. Single. Willing to travel and/or relocate anywhere in the U. S.
REFERENCES:	References will be furnished upon request.

Form NRC-313 I
Items 16 & 17

Radiation Protection Officer's Resumé

Nimia E. Irizarry, Head, Health & Safety Div. CEER (See resume attached.)

Training and Experience

Type of Training	Where Trained	Duration of Training	On the Job	Formal Course
Principles and practices of radiation protection...				
1. Seminar in radiological health	Center for Energy and Environment Research (CEER), (Formerly Puerto Rico Nuclear Center), in coordination with Medical Sciences Campus U.P.R. Rio Piedras, Puerto Rico.	5 months	Yes (No)	(Yes) No
2. Radiation hazards and protection		5 months		
3. Laws and regulations in radiological health		5 months		
4. Safety in reactor operations		5 months		
5. Field practice		2 months		
Radioactivity measurement standardization and monitoring techniques and instruments...	Same as above		Yes (No)	(Yes) No
1. Radiation detection		5 months		
2. Radiation dosimetry		5 months		
3. Decontamination and waste management		5 months		
4. Radioactivity of the environment		5 months		
Mathematics and calculations basic to the use and measurement of radioactivity...	Same as above		Yes (No)	(Yes) No
1. Radiation physics		5 months		
2. Radiation chemistry		5 months		
Biological effects of radiation...	Same as above		Yes (No)	(Yes) No
1. Radiation effects in mammals and humans				

Form NRC-313 I
Items 16 & 17

Radiation Protection Officer's Experience with Radiation.

Isotope.	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
CO-60	16413 Ci	Puerto Rico Nuclear Center	4 years	Gamma irr. fac.
Ra-226	21.6 mg	Puerto Rico Nuclear Center	4 years	Instr. and film cal.
Cs-137	20 Ci	Puerto Rico Nuclear Center	4 years	Instr. and film cal.
Pu Be	15 g Pu	Puerto Rico Nuclear Center	4 years	Instr. and film cal.
TRIGA FLIP reactor	2 MW	Puerto Rico Nuclear Center	4 years	Radiation Protection Officer

Form NRC-313 I
Items 16 & 17
Resume of the Radiation Protection Officer

Additional Experience:

Total of 12 years working with radioisotopes. Four years as Research Assistant I to III working in neutron activation analysis and spectrometric analysis of samples.

Eight years as Radiation Safety Officer, 7 of which have been as Head, Health and Safety Division Center for Energy and Environment Research.

Three years as consultant RPO of the Department of Agriculture - Laboratorio Agrologico- Dorado, Puerto Rico Lic. No. 52-18221-01 .

Two years Consultant RPO for Alergan America, Hormigueros, Puerto Rico Lic. No. 52-19324-01 .

Four years RPO for the Mayaguez Campus, University of Puerto Rico Licenses Nos. SUD- 1335 (Nat U) ; 52-10510-04 (Byprod. Matl) ; SNM- 1836 (PuBe sources)

Note: The Center for Energy and Environment Research is a Research Institution that has been sponsored by the Department of Energy (formerly ERDA and AEC) for 25 years.

FORMS

HEALTH PHYSICS ASSAY REPORT

Bldg. _____ Room _____

Date _____

Taken by _____

Counted by _____

Date counted _____

☐ Notify _____ on ext. _____ of results. ☐ Notified.

☐ Send copy of report to: _____ Code _____

To be counted for

☐ ALPHA
Background _____ c/m Geometry _____

☐ BETA-GAMMA
Background _____ c/m Geometry _____

Sample Number	Beta-Gamma	Alpha

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

Remarks:

HPO-FORM 001	CENTER FOR ENERGY AND ENVIRONMENT RESEARCH APPLICATION FOR RADIOISOTOPE PROCUREMENT	Approval No

A. Submit two copies to Radiation Protection Officer.

B. Each approved application is valid only for the user, radioisotope, millicurie amount, application, location and current fiscal year.

C. All requisitions for the purchase or procurement of radioisotopes must be accompanied with form 002 and must be directed to the Radiation Protection Officer

D. All radioisotope transfers between approved users must be preceded by completion and approval of supplementary form 003.

E. Radioactive waste will be disposed by the Radiation Protection Officer.

1. Name, dept., college address and extension of applicant performing immediate supervision of laboratory operations.

2. Brief past experience and training of above named individual in the use of radioisotopes.

3. Name, dept., college address and extension, and radioisotope experience of individuals using the produced radioisotopes under applicants supervision (if student, so state).

4. Radioisotope	5. Physical and chemical form	6. Other potential hazard

7. Activity limits

_____ mCi, maximum to be used in a single experimen

_____ mCi, estimated to be ordered per shipment

_____ mCi, estimated to be ordered per fiscal year

8. Will the radioisotope be used in humans? Yes (_) No (_)

(continued on reverse side)

9. Proposed procedure (as detailed as possible, including concern for other hazards, rooms involved for usage or storage, etc. If any of these rooms are not under the direct control of the applicant, please indicate).

10. Monitoring instruments available in the immediate area.

11. Name and address of supplier.

Radiation Protection Officer will be the recipient of all radioisotopes and will deliver them to the applicant after performing an appropriate survey.

12. Signature of Applicant_____ Date_____

13. Signature of Approval by
Radiation Protection Officer_____ Date_____

Expiration date of this Authorization: -- June 30, 19_____

RIO-FORM 002

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
RADIOISOTOPE CONTROL

1. Purchase Order No._____ Approval No._____

2. Requisitioner_____ Dept._____

3. Arrival Date_____ Time_____ Carrier_____

4. *RPO Notified Yes (_) No (_) Date_____ Time_____

5. Person that Notified_____

(TO BE FILLED BY SURVEYOR)

6. Survey Date_____ Time_____ Surveyor_____

7. Condition of Package: Good (_); Punctured (_); Stained (_); Crushed (_)
Wet (_); Other (_)

8. Radiation Level: Maximum mR/hr (_____); mR/hr on Contact (_____)
mR/hr at 1 Meter (_____)

9. Do Packing List and Package Contents Agree?
Radionuclide (__) Yes If No, Explain Difference_____
Amount (__) Yes _____
Chemical Form(__) _____

10. Smear Results Contaminated (__) Not Contaminated (__)
Contamination Level_____dpm
Where Contaminated_____

11. If Package was Shipped with Dry Ice, was Dry Ice Present in Package at the Time of the Survey? Yes (_) No (_) N/A (_)

12. Final Disposition of Package_____

13. Delivered To:_____ Date_____

CERTIFIED CORRECT: _____
Surveyor's Signature

_____
Receiver's Signature

*RPO-Radiation Protection Officer

Original to Radiation Protection Officer; Duplicate to Requisitioner; Triplicate to Property Office.

RPO-FORM 003

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
RADIOISOTOPE TRANSFER PERMIT

1. Requisitioner _____ Dept. _____

   Date _____

2. Present Custodian _____ Dept. _____

3. New Custodian _____ Dept. _____

4. Present Storage Location _____

5. Proposed New Storage Location _____

6. Description of Material to be transferred _____

   _____ Quantity _____

7. Description of Container _____

8. Proposed Date for transfer _____

9. Person to do the transfer _____

10. Remarks _____

The requisitioner certifies that the new custodian is authorized by the Radiation Safety Committee to use radioisotopes in the form described above.

Date _____ _____
Signature

(TO BE FILLED BY THE RADIATION PROTECTION OFFICER)

Permit Granted Yes (__) No (__) If No, state reasons _____

_____

Date of transfer _____ Transferred by _____

CERTIFIED CORRECT: _____
Radiation Protection Officer's Signature

_____
New Custodian's Signature

Original to Radiation Protection Officer; Duplicate to Requisitioner, Triplicate to new Custodian.

HPO-Form 004

CENTE 'OR ENERGY AND ENVIRONMENT RES RCH
RADIOISOTOPE USE PROPOSAL

1. Name of Person Submitting Request _____

2. Date of Submission _____ Date Experiment will start _____

3. Radioisotope (s) to be used _____ Form _____

   Amount _____ For How Long? _____

4. Is the Radioisotope to be Purchased? Yes (_) No (_)

   If No, Where will it come from? _____

5. Persons Involved in the Experiment _____

   _____

6. Location of Experiment _____

7. Description of Experiment _____

   _____

   _____

(To be Filled in the Radiation Safety Committee Meeting)

8. Date of Meeting _____ Time _____

9. Members Present _____ _____

   _____

10. Experiment Approved Yes (_) No (_) If No, State Reasons _____

    _____

11. Approved with Restrictions Yes (_) No (_) Restrictions _____

    _____

    _____

CERTIFIED CORRECT: _____
Chairman's Signature

Original to Radiation Protection Officer, Duplicate to Requisitioner, Triplicate to Radiation Safety Committee File.

RADIOLOGICAL EVALUATION
STUDY AREA 4
EL VERDE RESEARCH STATION
LUQUILLO FOREST
LUQUILLO, PUERTO RICO

INTRODUCTION

Between 1964 and 1976, the U.S. Atomic Energy Commission (AEC), under an agreement with the U.S. Department of Agriculture Forest Service, supported a terrestrial ecology program in a section of the Luquillo Forest, known as the El Verde Research Station. This program was conducted through the Puerto Rico Nuclear Center (later renamed CEER, Center for Energy and Environment Research), at the University of Puerto Rico (UPR). In 1976, control of activities at the El Verde site was transferred from the AEC successor, ERDA (presently the Department of Energy (DOE)), to the University of Puerto Rico; the agreement with USFS was also transferred to UPR.

The program included the use of radioactive materials, for direct exposure of vegetation and for tracing biopathways. Most radionuclides used in the projects were of short half-life or were in the form of sealed sources. Sealed radioactive sources have been removed; materials used for labeling (tagging) vegetation have mostly decayed or dispersed to the extent that residual activity levels are at or near ambient background.

One area which still retains activity in excess of background levels is Study Area 4, east of the Research Station. In September 1968, a tree of the species Matayba dominguensis was injected with 460 microcuries (μCi) of Cs-137; at about the same time, a nearby tree of the species Dacryodes excelsa in this Study Area was injected with a mixture of Rb-86 (17.69 mCi), Sr-85 (0.19 mCi), and Mn-54 (0.34 mCi).[1,2] The purpose of these injections was to study mineral cycling and metabolism. The Rb-86, Sr-85, and Mn-54 have relatively short radiological

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Prepared by the Energy/Environment Systems Division of Oak Ridge Associated Universities, Oak Ridge, Tennessee, under Contract DE-AC05-76OR00033 with the U.S. Department of Energy.

half-lives (maximum of about 300 days for Mn-54); residual activities are, therefore, negligible after almost 25 years of decay. The half-life of Cs-137 is approximately 30 years, and, thus, at this writing, as much as 58% (270 μCi) could theoretically remain. In the late 1970's and early 1980's, about 43 kg of contaminated soil was removed from around the roots of the Matayba dominguensis tree by UPR and disposed of in Oak Ridge, TN; the total activity removed was not determined and, therefore, the balance of Cs-137 at the Study Area 4 cannot be determined, without extensive subsurface investigations.

The residual Cs-137 activity in Study Area 4 is licensed to the University of Puerto Rico by the Nuclear Regulatory Commission (License 52-19434-02). The University has indicated a desire to divest itself of the responsibility for this site; it has been suggested that this responsibility be transferred to the U.S. Department of Agriculture (USDA) by adding the site to their existing radioactive materials license with the NRC. The USDA has requested an evaluation of the radiological conditions and associated potential environmental and public health impacts, prior to further consideration of such a transfer.[3] This report addresses these issues.

SITE DESCRIPTION

The Luquillo Forest, also known as the Caribbean National Forest, is located in the northeast portion of Puerto Rico, approximately 15 km from the town of Luquillo and about 35 km from San Juan (Figure 1). The Forest, occupying approximately 11,300 hectares, receives up to 600 cm of rainfall, annually. It is a dense evergreen forest, containing a wide variety of native flora; it is also a wildlife refuge for about 50 bird species and numerous amphibians and reptiles. Major uses of the forest are hiking, camping, and sight-seeing. With exception of several principle roads and a few improved trails, the Luquillo Forest is relatively inaccessible. Interior trails are typically narrow, rugged, and steep.

The El Verde Research Station is in the northwest corner of the Luqillo Forest and is reached via Highway 186 (Figures 1 and 2). Study Area 4 is about 500 m east of the Research Station Field Office. The study area is accessed via a winding, occasionally steep trail from the Field Office. The access trail is about 650 m in length and includes a cable suspension bridge, over

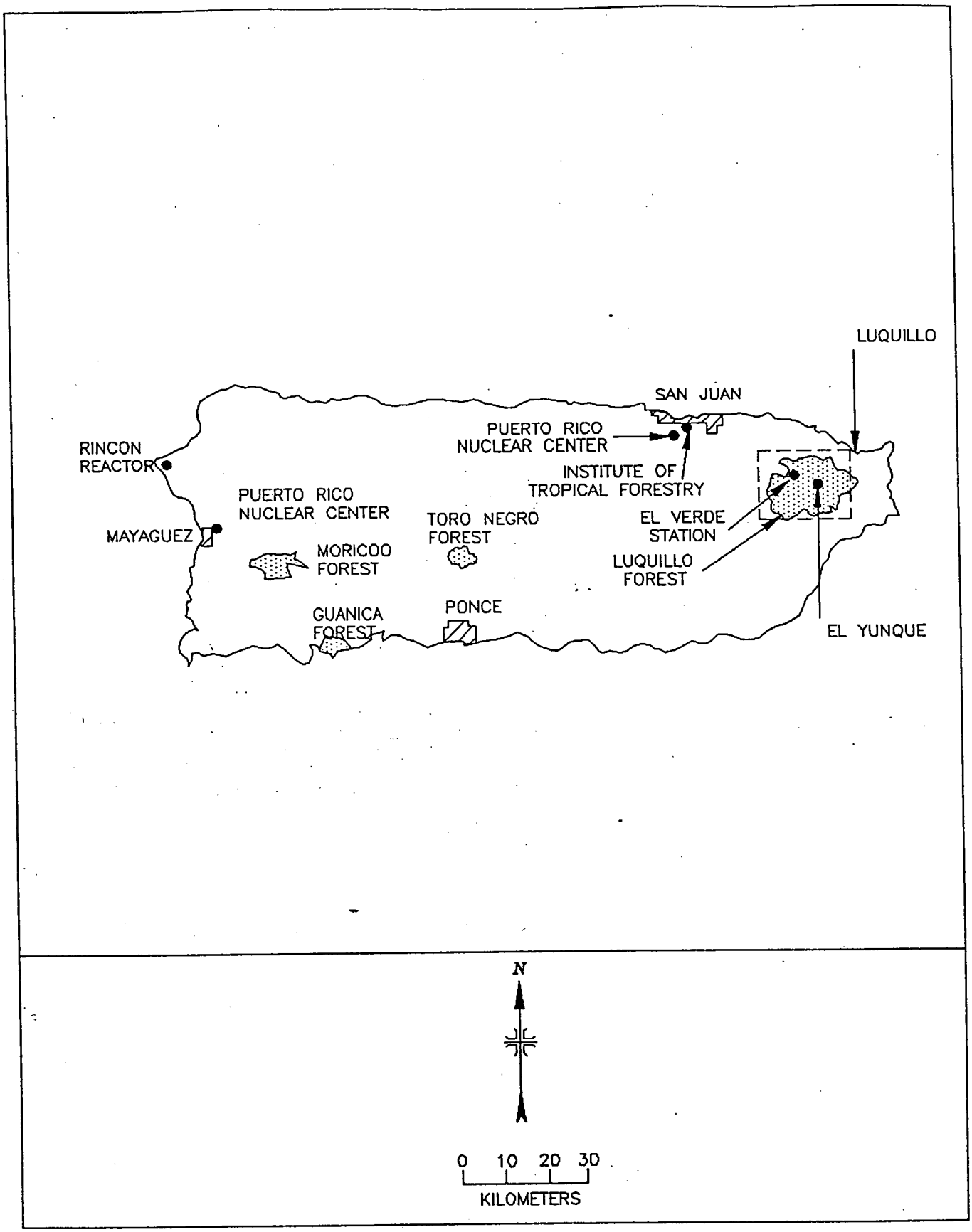

FIGURE 1: Map of Puerto Rico – Location of Luquillo Forest and El Verde Research Area (From "Radiological Survey Report for El Verde Research Station," CEER–X–115, Health and Safety Division, CEER, May 1983 (Revised)

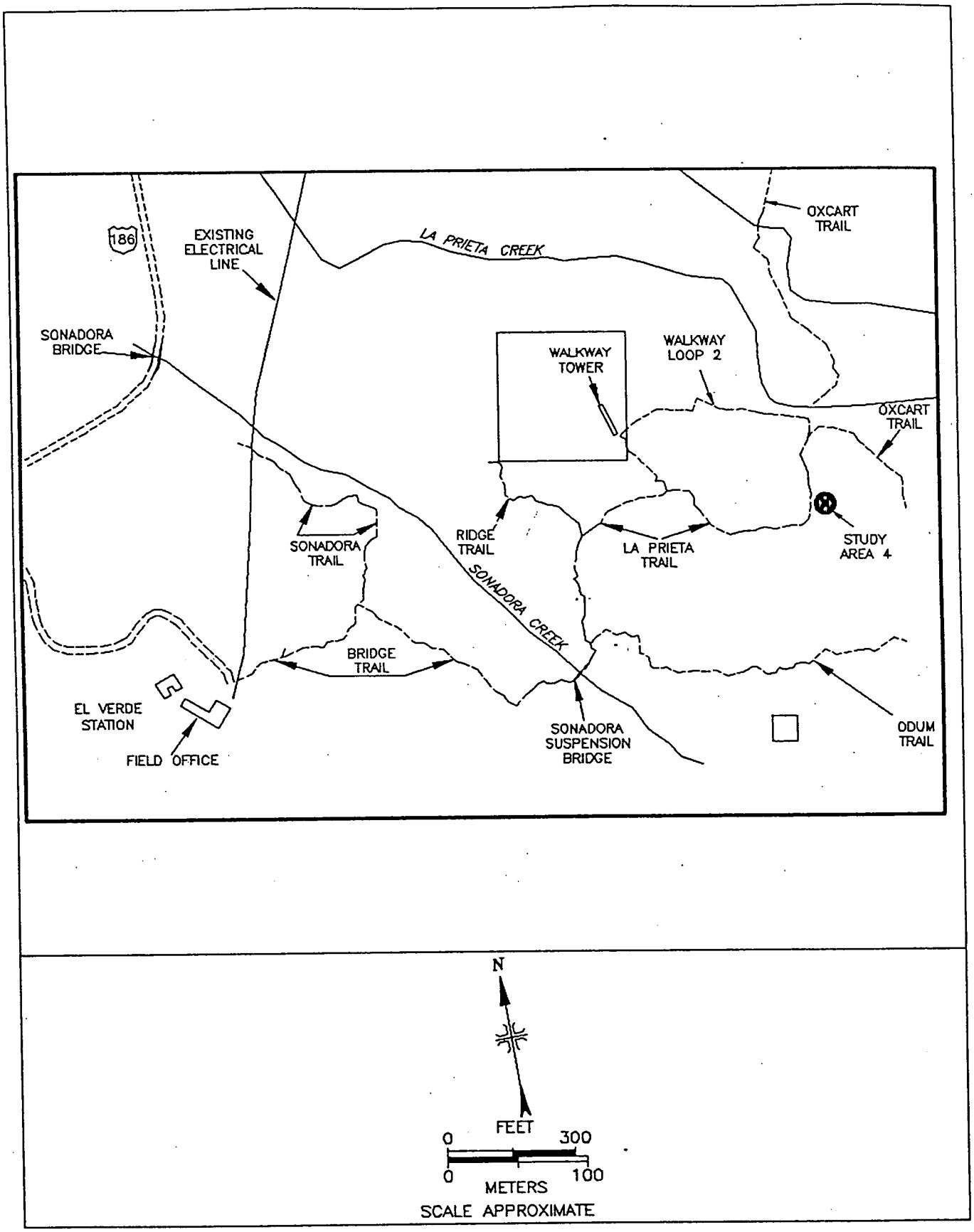

FIGURE 2: El Verde Research Station – Location of Cesium–137–Labeled Tree in Study Area 4

the Sonadora Creek. Study Area 4 is located on a small knoll, slightly above this trail; the closest point on the trail to the region of contaminated soil is approximately 8 m. The trunk of the Matayba dominguensis tree is presently approximately 1.8 m in circumference at 1 m above the ground surface. Fencing, with postings indicating the presence of the Cs-137, previously surrounded the Study Area. This fence is not presently standing and warnings are therefore not readily visible. A plot plan of Study Area 4 is shown in Figure 3.

Several previous radiological surveys have been performed in the Study Area during the past 10 years.[2,4,5] These surveys, by UPR, Oak Ridge National Laboratory, and the Environmental Survey and Site Assessment Program of Oak Ridge Institute for Science and Education provide similar results and do not identify significant changes in the levels and distribution of the Cs-137 contaminations. These surveys indicate that the residual activity is concentrated at the base of the trunk and in the small root system of the previously injected tree. The maximum Cs-137 concentration is 370 pCi/g, in the soil around the root system, directly beneath the tree. Within several meters of the tree the Cs-137 concentration in surface soil ranged from about 10 to 250 pCi/g. Beyond this distance, the concentration decreases and ranged from 1 pCi/g (background) to 2.5 pCi/g at 5 m from the tree.

Maximum direct gamma radiation levels are at contact with the root system, directly beneath the tree. The highest level noted is about 200 μR/h, in contact with the exposed roots and soil. On contact with the tree itself, at 1 m above ground level, the direct radiation level is a maximum of 15 μR/h. At approximately 3 m from the tree the direct radiation level decreases to ambient background levels (2-3 μR/h) at both surface contact and at 1 m above the surface. No evidence of "hot-spots", that would suggest migration of activity, have been noted out to 5 to 10 m beyond the Study Area perimeter.

A core of wood from the Cs-137 injection site contained 77.4 pCi/g, and small roots contained 109 pCi/g. These particular locations are considered as representing maximum Cs-137 concentrations in the tree itself. Leaves, collected from the surface near the tree contained 5.5 pCi/g.

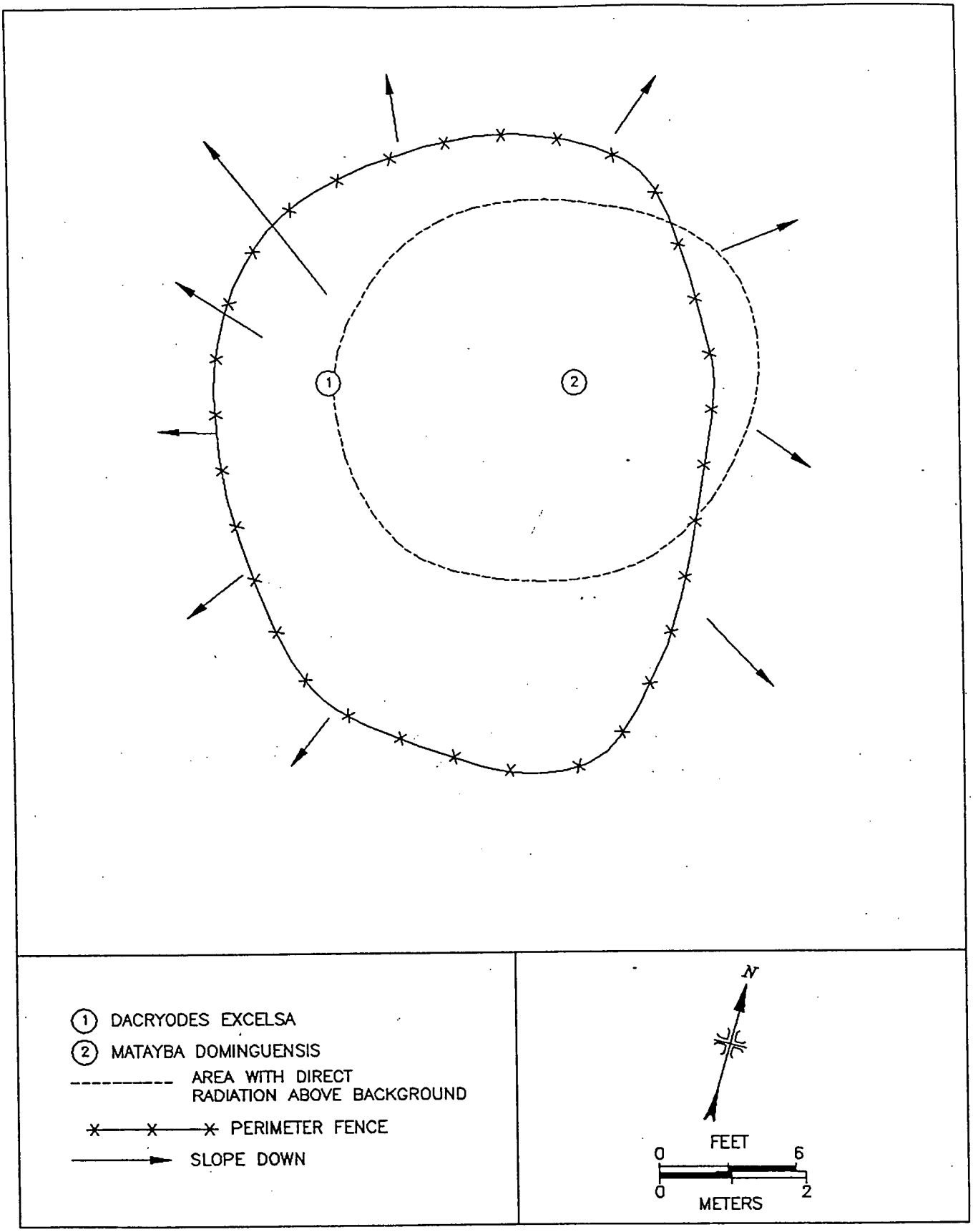

FIGURE 3: Study Area 4 – Location of Experimental Trees and Results of Surface Gamma Scan

RADIATION EXPOSURE EVALUATION

In evaluating the potential future impact of the radioactivity at Study Area 4 on workers and the public, several basic conditions were considered. The first of these conditions assumes no changes in site use, i.e. the site will continue as a research area within a National Forest. The second condition assumes that the area will be released for development, in which case timber will be cut and burned and the land surface graded to enable construction of access roads, structures, and other improvements. Because of uncertainties in the total activity Cs-137 currently remaining, it is assumed for the purpose of these estimates that the quantity originally injected has undergone radioactive decay, but not other actions have occurred to significantly reduce the amount; the total activity used for these estimates is thus assumed to be 270 μCi, although the actual quantity may be considerably less. Also, because of uncertainties in the distribution of the activity between the tree and soil, for calculations applied to only one of these media it has been conservatively assumed that the entire quantity of Cs-137 (270 μCi) is contained in the media of interest.

I. Condition 1 - Site Use Unchanged

According to the El Verde Research Station staff, other study areas in this portion of the Luquillo Forest will require surveillance for at least an additional 30-40 years.[6] They consider it unlikely that there will be development, which would increase the amount of worker or public traffic near Study Area 4 or which would result in disturbance of the contaminated soil or tree. Under such circumstances, direct gamma radiation would be the most probable exposure pathway from Cs-137 in the soil and tree.[7,8] Site staff members spend less than 1 hour per year within 10 m of the tree; public traffic is uncommon in this area of the Forest and annual exposure time of a member of the public is estimated as less than that of the staff.[6] If an individual were exposed to the maximum level of direct gamma radiation measured at 1 m above the ground surface (15 uR/h in contact with the tree) for 1 hour annually, the accumulated exposure would be 15 uR. This is approximately a dose equivalent rate of 0.01 mrem/y, above background.

Surveys have not identified evidence of surface migration of Cs-137 from the Study Area; potential impact on surface waters are thus considered negligible.[2,4,5]

Based on NUREG/CR-5512, total soil contamination of 1 pCi of Cs-137 would result in an annual total dose equivalent of 6.55×10^{-12} mrem, via a drinking water pathway.[7] A total site Cs-137 inventory of 270 uCi would therefore have an associated dose equivalent of about 0.001 mrem/y. This calculated value is based on conservative and "default" assumptions and contains a high level of uncertainty, because of the likely overestimate of total activity and the unknown effects of more abundant rainfall and the mobility of Cs-137 in soil for this locale. However, due to the absence of wells in the vicinity of the Study Area and the low dose equivalent rate estimated, this drinking water pathway is also considered negligible.

II. Condition 2 - Site Development

By clearing and grading the area, it is assumed that the total estimated quantity of activity (270 uCi) is distributed in the upper 15 cm soil layer of a 100 m^2 area. If the density of the soil is assumed to be 1.5 g/cm^3, the resulting average concentration of Cs-137 in this soil layer would be 12 pCi/g. The exposure scenario with the greatest potential radiation dose to a site occupant from Cs-137 is surface soil is the residential scenario.[7,8] The residential scenario, developed in NUREG/CR-5512, equates 0.71 pCi/g in soil with an annual dose equivalent of 1 mrem.[7] Using this relationship, a soil concentration of 12 pCi/g would yield a dose equivalent rate of 17 mrem/y to a site resident. It is acknowledge that uniform mixing would not likely occur and the distribution would be non-homogeneous, with small volumes of soil having higher concentrations of Cs-137. However, due to overestimates of input parameters and averaging of the exposure over a year, the resulting dose equivalent is considered to be a conservative overestimate.

The Matayba domeniguensis tree is not a species used for construction. It could be burned for cooking or heating; however, considering the size of the tree and the inaccessibility of its location, it is unlikely that it would be removed from its present location for such a use. The likely fate of this tree, if the area were cleared for development, is that it would be burned in

place, along with most of the other vegetation. Because of uncertainties as to the volatility of the Cs-137, two possibilities representing the extreme cases, are considered, one is that all of the Cs-137 remains in the ash; the other is that all of the Cs-137 is volatilized, creating an inhalation exposure potential.

Assume that all of the Cs-137 remains in the ash and is combined with the soil during grading. The resulting concentration and associated does equivalent from this mixture would be the same as described above, for the residential scenario, i.e. 12 pCi/g and 17 mrem/y, respectively.

The procedure presented in NCRP Commentary #3 may be used to estimate the consequences of a radioactive initial release to the atmosphere.[9] For this situation the procedure recommended for Screening Level II is followed. Input parameters assumed are:

total activity in tree	270 uCi
portion of activity voltalized	100%
time for combustion	24 h
wind in direction of exposures	25%*
distance to exposed individual	100 m*
exposure time	8 h
wind speed	2 m/s*
release height above ground surface	0
diffusion parameter (0 height, 100 m)	$3.5 \times 10^{-3} m^{-2}$

*recommended default values for Screening Level II application

The release rate for combustion of the tree in 1 day is:

$$\frac{270\ \mu Ci}{86400\ s} = 3.13 \times 10^{-3}\ \mu Ci/s$$

At 100 m from the burn site, the resulting air concentration would be:

$$\frac{3.13 \times 10^{-3}\ \mu Ci/s \times 0.25 \times 3.5 \times 10^{-3}\ m^{-2}}{2\ m/s} = 1.37 \times 10^{-6}\ \mu Ci/m^3$$

At an inhalation rate of 0.04 m^3/min (ICRP-30 for heavy physical labor), the total inhaled activity, during an 8 hour exposure would be:

$$1.37 \times 10^{-6}\ \mu Ci/m^3 \times 0.04\ m^3/\text{min} \times \frac{60\ \text{min}}{h} \times 8\ h = 2.63 \times 10^{-5}\ \mu Ci$$

From Table C-3 of NCRP Commentary No. 3, the committed total effective dose equivalent from inhalation of Cs-137 is 3.1×10^7 mrem/Ci. Inhalation of 2.63×10^{-5} uCi would thus deliver an estimated committed dose equivalent of:

$$2.63 \times 10^{-5}\ \mu Ci \times 3.1 \times 10^7\ \text{mrem/Ci} \times 10^{-6}\ \text{Ci}/\mu Ci = 8.15 \times 10^{-4}\ \text{mrem}$$

This value is considered an overestimate, because plume rise and diffusion, due to temperature of the combustion gases, is ignored and the extreme cases of total activity in the wood and fraction of the Cs-137 volatilized, are assumed.

The following table summarizes the results of these evaluations:

Condition	Exposure Pathway	Estimated Dose Equivalent
Site Use Unchanged	direct gamma radiation	0.01 mrem/g
Site Use Unchanged	surface water	negligible (not calculated)
Site Use Unchange	drinking water	0.001 mrem/y
Site Development	combined residential scenario	17 mrem/y
Site Development	Cs-137 remains in ash/soil	17 mrem/y
Site Development	Cs-137 volatilized-inhalation	8.2×10^{-4} mrem*

*Committed dose equivalent

Of the various scenarios considered, the maximum estimated dose equivalent to an individual, is the result of residential use of the land, following clearing and grading of the surface. The

estimated dose equivalent for this scenario is 17 mrem/y, above background. The other scenarios all had estimated dose equivalent levels of less than 1 mrem/y, above background. For comparison, the NRC and DOE recommended limits for a member of the public are an average of 50 mrem/y and 100 mrem/y, respectively.[10,11] All potential exposure scenarios were well below that recommended limit, and considering that conservative assumptions were used for most of those estimates, the actual doses would likely be even less.

SUMMARY

As much as 270 μCi of Cs-137, from a vegetation tagging experiment, conducted approximately 30 years ago, is present in soil and a Matayba dominguensis tree in a small secluded area near the El Verde Research Station of the Luquillo Forest. This radioactive material is currently regulated under a Nuclear Regulatory Commission license with the University of Puerto Rico. An evaluation of the potential radiological impact of this Cs-137 on Forest workers and the public was performed. This evaluation indicates that radiation doses would be expected to remain well within regulatory limits of the NRC and DOE, even assuming conservative site conditions, which likely overestimate the doses. On the basis of these results, it can be assumed that leaving the tree soil at the current location, either with continued licensing restrictions and surveillance of without future regulatory control, will assure an adequate level of radiological protection. The alternative would be to remove and properly dispose of the contaminated tree and soil. This would be difficult to perform under present site conditions which restrict accessibility. Such an action would require destruction of the mature tree and would also likely result in damage to additional portions of the Forest in the immediate area and along the transport routes.

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1. "The Rain Forest Project Annual Report," PRNC-129, Puerto Rico Nuclear Center, June 1969.

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5. "Radiological Measurements, Study Area 4, Ed Verde Research Station, Luquillo Forest, Luquillo, Puerto Rico," Oak Ridge Institute of Science and Education, May 1993.

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7. W. E. Kennedy, Jr. and D. L. Strenge, Residual Radioactive Contamination from Decommissioning, PNL - 7994, Vol 1. (NUREG/CR-5512), Pacific Northwest Laboratory, October 1992.

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RADIOLOGICAL MEASUREMENTS
STUDY AREA 4
EL VERDE RESEARCH STATION
LUQUILLO FOREST
LUQUILLO, PUERTO RICO

Between 1964 and 1976, the U.S. Atomic Energy Commission (AEC), under an agreement with the U.S. Department of Agriculture, Forest Service (USFS), supported a terrestrial ecology program in a section of the Luquillo Forest, known as the El Verde Research Station (Figure 1). This program was conducted through the Puerto Rico Nuclear Center (later renamed CEER, the Center for Energy and Environment Research), at the University of Puerto Rico (UPR). In 1976, control of activities at the El Verde site was transferred from the AEC successor, ERDA (presently the Department of Energy (DOE)), to the University of Puerto Rico; the agreement with USFS also was transferred to UPR.

Main study areas were located on the northwest side of the Forest, approximately 200 to 800 m from the Research Station (Figure 2). Most radionuclides used in the projects were of short half-life (physical and/or biological half-life) or were in the form of sealed sources. Sealed radioactive sources have been removed; materials used for labeling (tagging) vegetation have mostly decayed or dispersed to the extent that residual activity levels are at or near ambient background.

One study area which still retains activity in excess of background levels is Study Area 4, about 700 m east of the Research Station. In September 1968, a tree of the species Matayba dominguensis was injected with 0.46 millicuries of Cs-137.[1] At about the same time, a nearby tree of the species Dacryodes excelsa in this Study Area was injected with a mixture of Rb-86 (17.69 mCi), Sr-85 (0.19 mCi), and Mn-54 (0.34 mCi).[2] The purpose of these injections was to study mineral cycling and metabolism. The Rb-86, Sr-85, and Mn-54 have

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Prepared by the Energy/Environment Systems Division of Oak Ridge Associated Universities, Oak Ridge, Tennessee, under Contract DE-AC05-76OR00033 with the U.S. Department of Energy.

relatively short radiological half-lives (maximum of about 300 days for Mn-54); residual activities are, therefore, negligible after almost 25 years of decay. The half-life of Cs-137 is approximately 30 years, and, thus, at this writing, as much as 55% (0.25 millicuries) could theoretically remain. The residual Cs-137 activity in Study Area 4 is licensed to the University of Puerto Rico by the Nuclear Regulatory Commission (license 52-19434-02). The Nuclear Regulatory Commission has raised questions regarding the future of the residual Cs-137 in the tree and surrounding soil; a major concern is the ultimate fate of the radioactively contaminated vegetation and soil, should the labeled tree die.[3]

Several previous radiological surveys have been performed in Study Area 4.[2,4] These surveys, by UPR and Oak Ridge National Laboratory, indicated that the residual activity was concentrated at the base of the trunk and in the small root system of the Matayba tree. In conjunction with the UPR survey in the late 1970's and early 1980's, about 43 kg of contaminated soil was removed from around the roots of the Matayba tree and disposed of in Oak Ridge, TN; the total activity removed was not determined and, therefore, the balance of Cs-137 at the Study Area cannot be calculated. Both the UPR and the ORNL surveys identified direct gamma radiation levels of about 200 μR/h in contact with the exposed roots and soil, after the soil had been removed. On contact with the tree itself, above ground level, the direct radiation level was up to 15 μR/h. Soil from around the root system of the tree, obtained during the ORNL survey, contained 370 pCi/g of Cs-137; at about 5 m from the tree, the Cs-137 concentration in a soil sample was 2.53 pCi/g. For comparison purposes, background exposure rates in the area typically range from 2 to 3 μR/h, and background Cs-137 ranges up to about 1.5 pCi/g.[4]

On March 12, 1993, at the request of the DOE/Oak Ridge Field Office, personnel from the Environmental Survey and Site Assessment Program of Oak Ridge Institute for Science and Education (ESSAP/ORISE), conducted additional radiological monitoring and sampling in Study Area 4. Gamma scans of the area, using sodium iodide detectors and countrate meters with audible indicators, confirmed that direct radiation is highest at the root system, directly beneath the tree; the highest level identified was about 200 times the background level. At approximately 3 m from the Matayba tree the direct radiation level decreases to background at

both surface contact and at 1 m above the surface. No evidence of "hot-spots" that would suggest migration of activity was noted out to 5 to 10 m beyond the Study Area perimeter. Samples of soil were collected from six locations within several meters of the tree. A sample of litter (leaves) from the general study area, a core boring from the Cs-137 injection site, and a sample of roots from beneath the Matayba tree were also collected. Analyses by solid state gamma spectrometry identified only Cs-137 in detectable concentrations. Concentrations measured are presented in Table 1. Soil from around the root system contained from 181 to 252 pCi/g of Cs-137. At 1 to 2 meters from the tree, surface soil ranged from 10.9 to 15.9 pCi/g. The core from the injection site contained 77.4 pCi/g and roots contained 109 pCi/g. Leaves collected from the surface near the tree contained 5.5 pCi/g. These findings are consistent with previous surveys and results of direct gamma monitoring.

Surveys indicate that the Cs-137 in Study Area 4 is limited to the immediate (within about 3 m) area of the previously injected tree. Only one tree is involved. Of the activity injected approximately half has decayed. Soil excavation and disposal by UPR about 1980 certainly further reduced the quantity of residual Cs-137. It is, therefore, unlikely that more than 200 pCi/g of Cs-137 remain; the actual amount may be considerably less. There is no evidence that the radioactive material is migrating or that there is any disturbance or recreational use of the area by the public. Potential for public exposure appears to be minimal. (The fencing around this Study Area has been knocked down and the radiation warning signs are not readily visible.) Removal at this time would require destruction of the mature tree, and it would be difficult to remove the contaminated soil and wood from the area over existing accesses. Considering the small potential risk from the residual Cs-137 it would seem logical to either continue under the current license agreement, until the quantity of radioactive material can be demonstrated by thorough survey or decay calculation to fall below the licensing level, or to perform a risk assessment and possibly terminate radiological controls. The risk assessment might demonstrate that an acceptable disposition of the tree and soil would be in-situ burial.

TABLE 1
Cs-137 CONCENTRATIONS IN SAMPLES FROM STUDY AREA 4 EL VERDE RESEARCH STATION LUQUILLO FOREST LUQUILLO, PUERTO RICO

Sample[a] ID	Cs-137 Concentration (pCi/g)[c]
Bkgd (plot 12-04-23)	1.0 ± 0.2[b]
1S	15.9 ± 0.6
2S	12.7 ± 0.7
3S	10.9 ± 0.6
4S	181 ± 4
5S	240 ± 3
6S	252 ± 3
1V (wood core)	77.4 ± 4.4
2V (roots)	109 ± 3
3V (leaves)	5.5 ± 1.0

[a]Refer to Figure 4.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]Net weight.

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1. "The Rain Forest Project Annual Report," PRNC-129, Puerto Rico Nuclear Center, June 1969.

2. "Radiological Survey Report for El Verde Research Station," CEER-X-115, Health and Safety Division, Center for Energy and Environmental Research, University of Puerto Rico, May 1983 (Revised).

3. Letter - Sandra Walden (NRC Region II) to Nimia Irigarry (UPR), "Transmittal and Explanation of NRC License No. 52-19434-02, Amendment No. 8," February 1, 1993.

4. "Preliminary Site Survey Report of the El Verde Research Station, Center for Energy and Environment Research, in the Luquillo Forest, Luquillo, Puerto Rico", Draft, ORNL/RASA-90/1, Oak Ridge National Laboratory, March 1990.

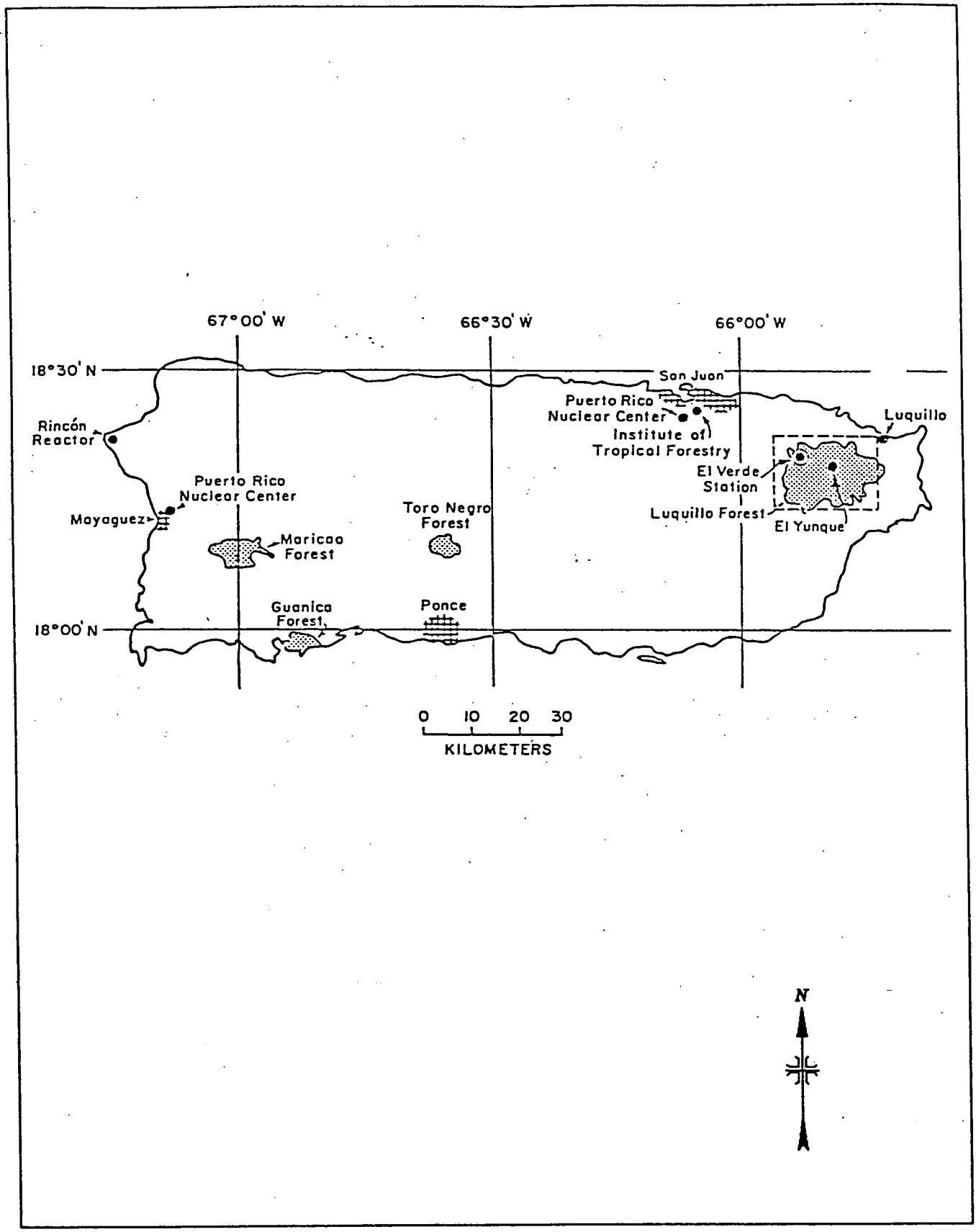

FIGURE 1: Map of Puerto Rico – Location of Luquillo Forest and El Verde Research Area (From "Radiological Survey Report for El Verde Research Station," CEER-X-115, Health and Safety Division, CEER, May 1983 (Revised)

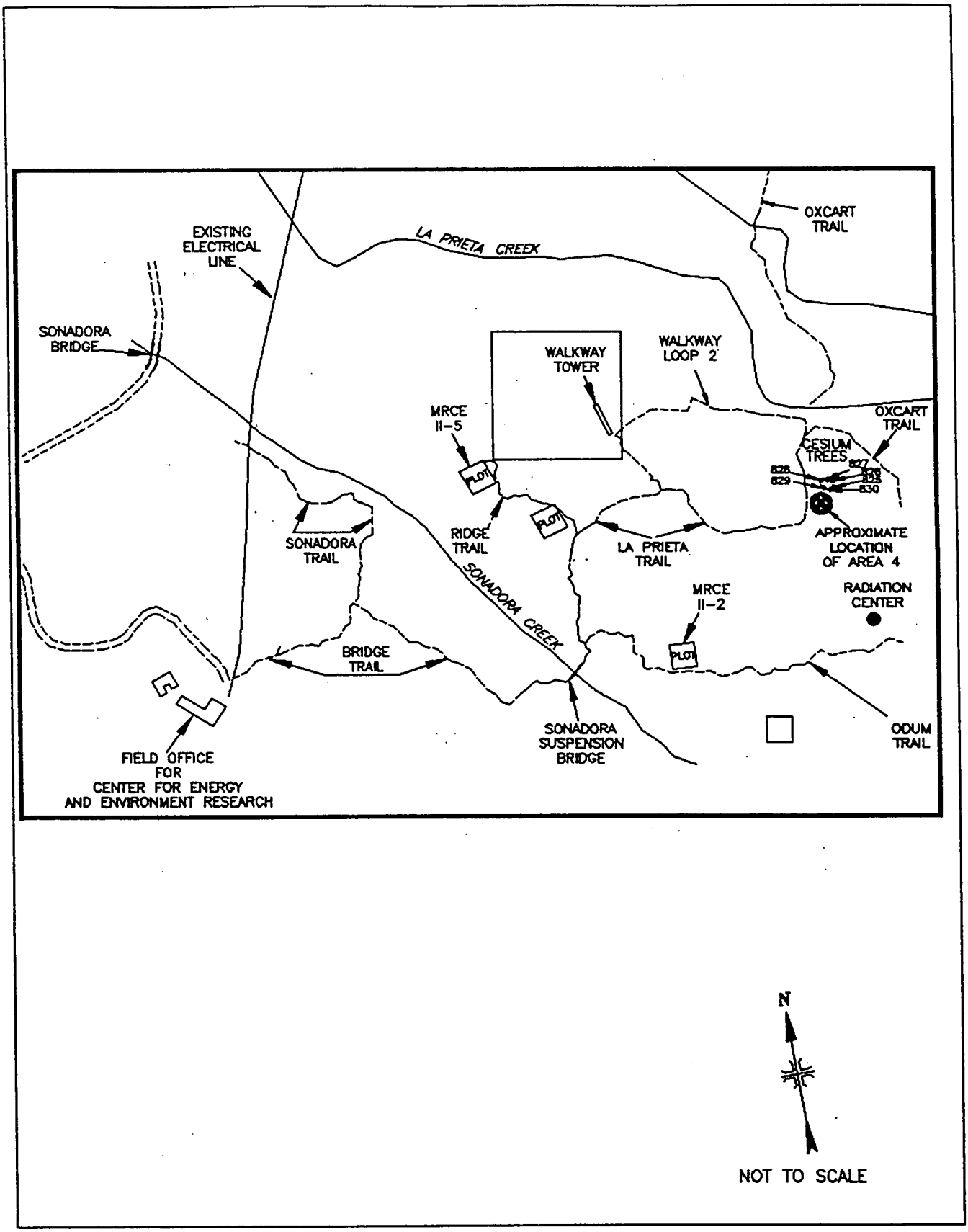

FIGURE 2: El Verde Research Station – Location of Cesium–137–Labeled Tree in Study Area 4

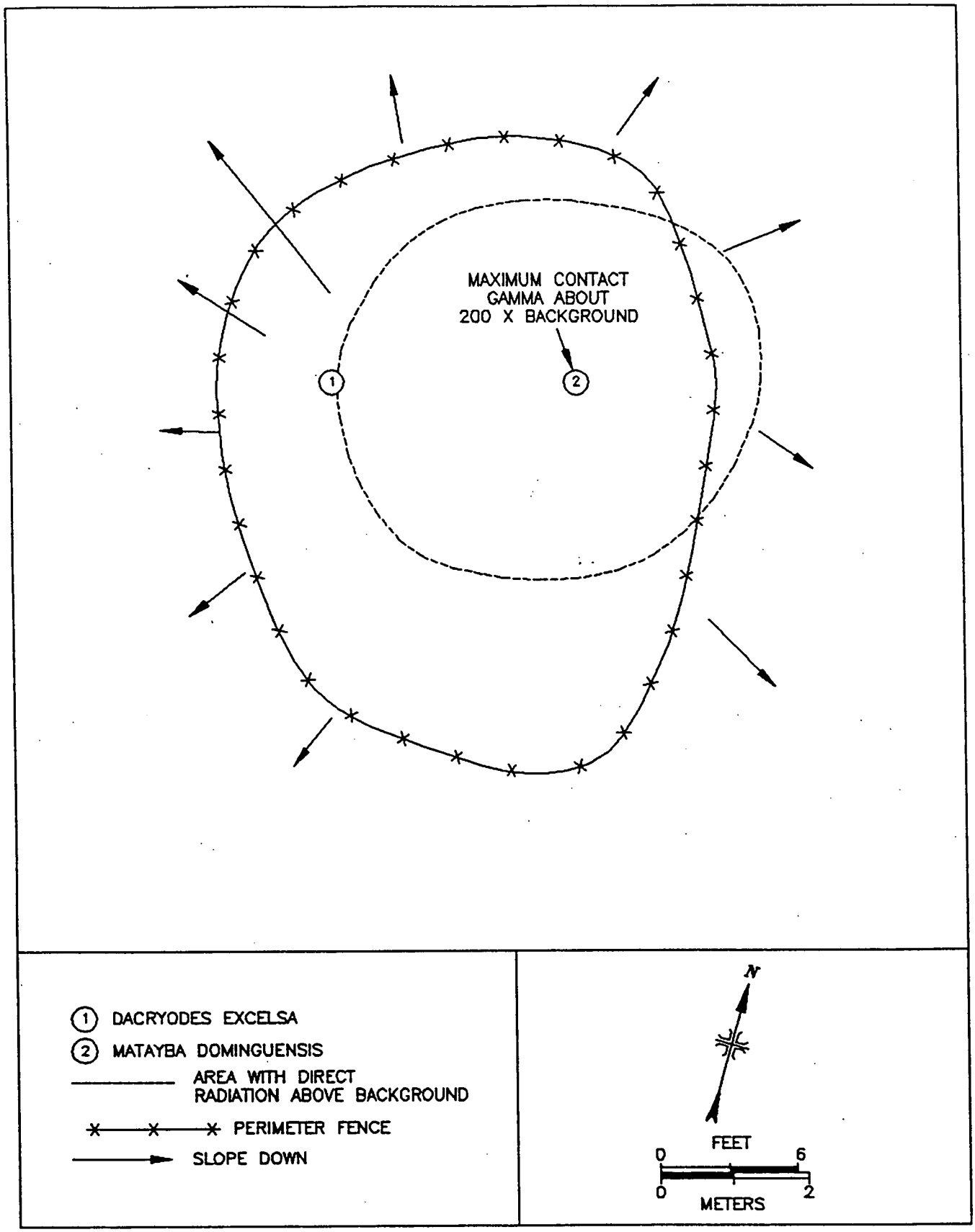

FIGURE 3: Study Area 4 – Location of Experimental Trees and Results of Surface Gamma Scan

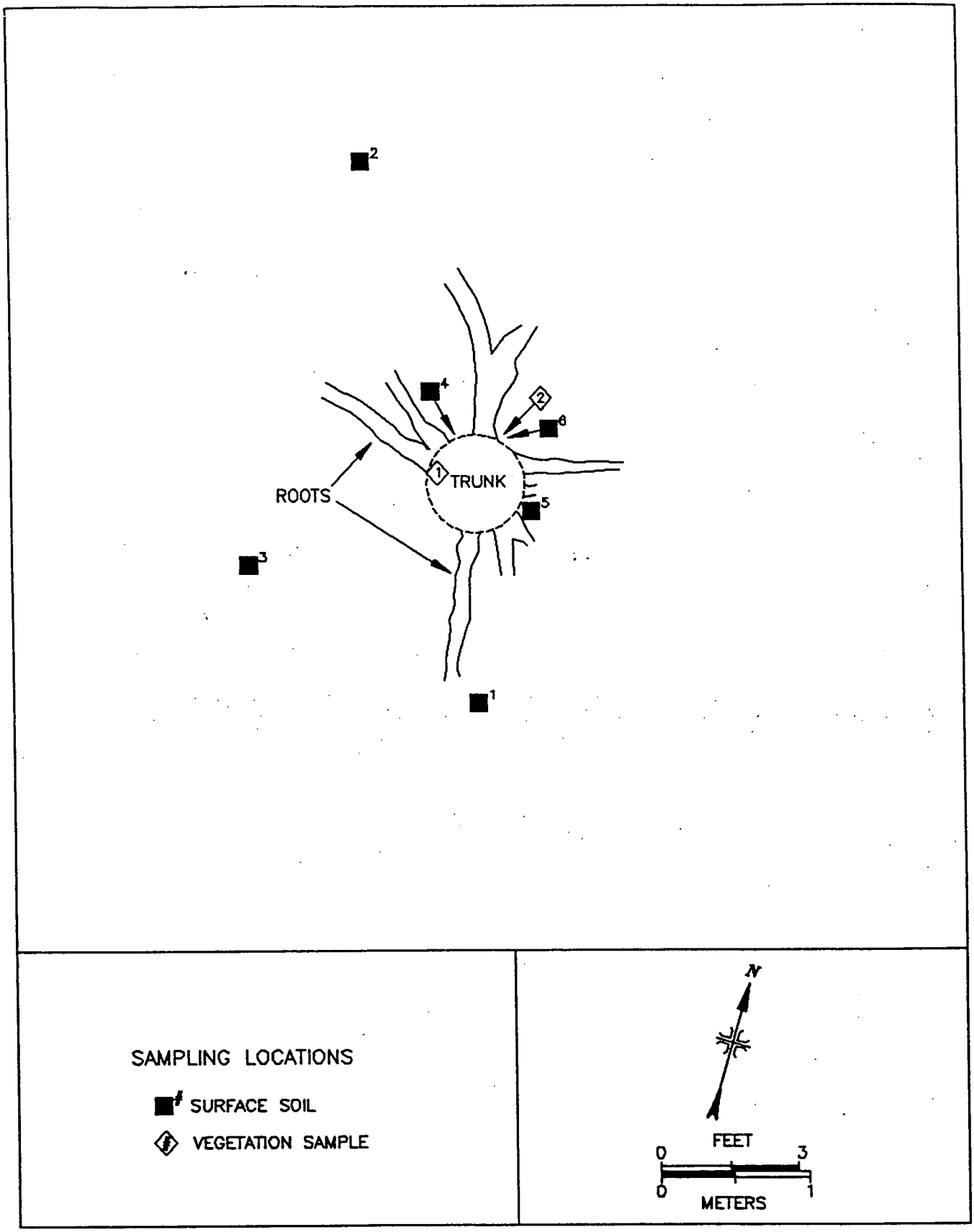

FIGURE 4: Cs–137–Tagged Matayba Dominguensis Tree (Tree 2) – Sampling Locations

TRANSFORMER
EL VERDE RESEARCH STATION
SAN LORENZO, PUERTO RICO

The attached information pertains to the analysis for Polychlorinated Byphenils conducted for the transformer located at the El Verde Research Station site in San Lorenzo, Puerto Rico. The analytical results showed 0 parts per million. This sample and analysis were made by the Puerto Rico Electric Power Authority (PREPA). Information was transmitted by Mr. Enrique Diaz from PREPA Transformer Program.

Nimia: 23/julio/96 9:40am

Llamo el Sr. Enrique Díaz de Protección Ambiental de la AEE. Tiene una información sobre un Transformador de Río Grande y un Certificado de Análisis. Favor comunicarse con él al tel: 289-4980. Gracias.

Arlan

Autoridad de Energía Eléctrica

HOJA DE TRAMITE PARA DOCUMENTOS POR FACSIMIL

Fecha: 2 de agosto de 1996 **Hora:** 0805

A: Wilfredo Ferrer
Dept. Salud y Ambiente **Núm. Fax:** 765-6270
Colegio Mayagüez

De: Enrique O. Cruz Ríe
Coord. Ambiental
Protección Ambiental AEE **Núm. Fax:** 289-4999

Asunto: Análisis transformadores de Arecibo

Enviado por: Enrique **Firma Autorizada:** Enrique

Número de Páginas: 2 (Incluye Hoja de Trámite)

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Wilfredo se necesita info. adicional
te mandamos comunic
Saludos Enrique

Si tiene preguntas o problemas con esta comunicación, favor de llamar al teléfono 289-4980

765-6270

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Pueblo: CANOVANAS Año: 1994 -

KVA	Galones	Marca
100.	34.	1 GENERAL ELECTRIC

Número de Serie: E928876-63Y
Nuestro Número : 47879
PPM: 0.

Dirección: CARR 186 KM 19.3 EST.EXPERIMENTAL EL VERDE

Fecha de Retiro	Fecha de Primer Transportador
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Manifiesto #: -0- Fecha de Destrucción: -0-

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Autoridad de Energía Eléctrica

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A: Wilfredo Feyes
Dept. Salud y Ambiental **Núm. Fax:** 765-6770
Colegio Mayagüez

De: Enrique O. Ortiz R.
Coord. Ambiental **Núm. Fax:** 289-4999
Protección Ambiental AEE

Asunto: Análisis transformadores Mayagüez

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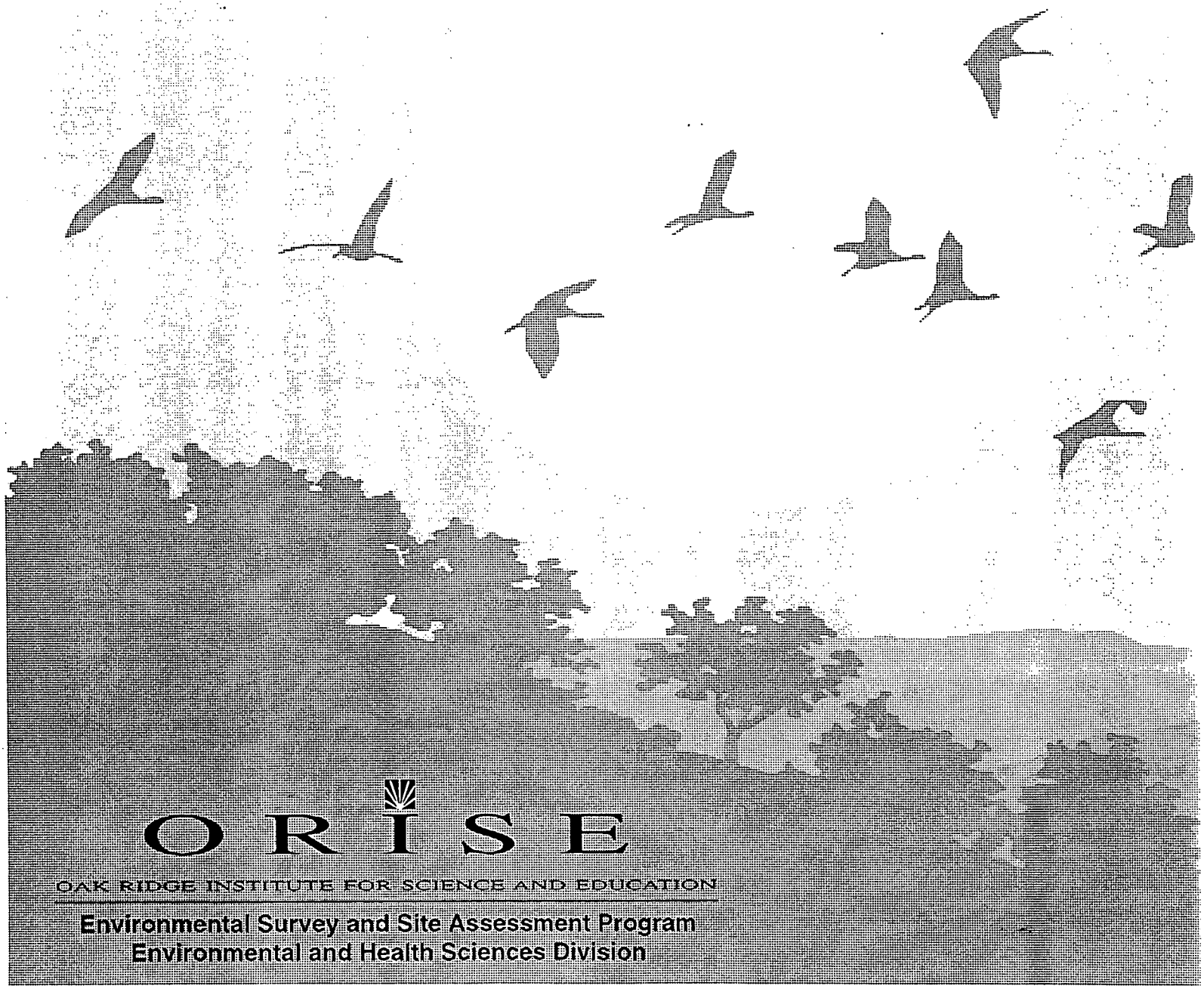
Número de Serie: E928876-63Y

PHASE I ENVIRONMENTAL SITE ASSESSMENT OF THE EL VERDE RESEARCH STATION LUQUILLO, PUERTO RICO

A. T. PAYNE

Prepared for the Office of Environmental Restoration
U.S. Department of Energy



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Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division

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Prepared by

A. T. Payne

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division
Oak Ridge Institute for Science and Education
Oak Ridge, TN 37831-0117

Prepared for the

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U.S. Department of Energy

FINAL REPORT

SEPTEMBER 1996

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

PHASE I ENVIRONMENTAL SITE ASSESSMENT
OF THE
EL VERDE RESEARCH STATION
LUQUILLO, PUERTO RICO

Prepared by: _____ Date: 9/4/96
A. T. Payne, Project Coordinator
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 9/5/96
T. D. Wantland, Industrial Hygienist
Safety & Environmental Protection Department

Reviewed by: _____ Date: 9/5/96
R. J. Kapolka, CIH, CSP, CHMM, Program Director
Safety & Environmental Protection Department

Reviewed by: _____ Date: 9/4/96
T. J. Vitkus, Survey Projects Manager
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 9/5/96
E. W. Abelquist, Assistant Program Director
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 9/5/96
W. L. Beck, CHP, Program Director
Environmental Survey and Site Assessment Program

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PROJECT STAFF

E. G. Bullington

CLERICAL STAFF

D. K. Ash
T. S. Fox
K. E. Waters

ILLUSTRATOR

T. L. Bright
T. D. Herrera

TABLE OF CONTENTS

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

µR/h	microroentgen per hour
ACBM	asbestos containing building materials
AEC	Atomic Energy Commission
ASTM	American Society for Testing and Materials
cc	cubic centimeter
CEER	Center for Energy & Environmental Research
CFR	Code of Federal Regulations
Ci	curie
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
FUSRAP	Formerly Utilized Sites Remedial Action Program
ha	hectares
kg	kilogram
km	kilometer
m	meter
NFPA	National Fire Protection Agency
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl
PREPA	Puerto Rico Electric Power Authority
UPR	University of Puerto Rico
USDA	U.S. Department of Agriculture
USFS	U.S. Department of Agriculture Forest Service

PHASE I ENVIRONMENTAL SITE ASSESSMENT OF THE EL VERDE RESEARCH STATION

INTRODUCTION AND SITE HISTORY

Between 1964 and 1976, the U.S. Atomic Energy Commission (AEC), under an agreement with the U.S. Department of Agriculture Forest Service (USFS), supported a terrestrial ecology program in a section of the Luquillo Forest known as the El Verde Research Station (Figure 1). This program was conducted through the Puerto Rico Nuclear Center, later renamed Center for Energy and Environmental Research (CEER) at the University of Puerto Rico (UPR). A memorandum of agreement was signed in 1964 between the USFS and the AEC separating 156 acres (62.4 hectares) of the Luquillo Forest into an experimental area in order to conduct detailed ecological studies of the effects of Cs-137 gamma radiation on tropical rainforests. Beginning in 1963 when the Research Station was established, a variety of research projects were conducted. Vegetation was identified and quantified, pollen was analyzed, climate and soil studies were performed, and other aspects of the rainforest were studied. Radiotracers were used during one of the studies of mineral cycling and forest metabolism. In 1976, control of activities at the El Verde site was transferred from the AEC successor, Energy Research and Development Administration (ERDA), presently the U.S. Department of Energy (DOE), to the UPR; the agreement with USFS also was transferred to UPR. DOE activities at the El Verde Research Station are now completed and plans are to return the property to the United States Department of Agriculture (USDA). DOE has requested that the Oak Ridge Institute of Science and Education (ORISE) Environmental Survey and Site Assessment Program (ESSAP) perform a Phase I Environmental Site Assessment of the El Verde Research Station. The purpose of this report is to summarize the findings of this assessment, including an evaluation of available historical records, and an evaluation of the results from a site inspection performed by DOE.

Records of previous inspection and clean-up activities were provided by the DOE. Government ownership of the property is historically well documented and, therefore, not considered to be questionable. Thus, ORISE was not requested to perform a verification of property ownership records. This assessment is limited by the completeness and accuracy of documentation provided by DOE.

This assessment is not intended to be an exhaustive reinvestigation of the activities performed in regard to this site, rather it is meant to provide an independent overview of work already completed to ensure that acceptable methodology was used during remediation/clean-up, and that the final status of the site is completely and accurately represented in the records. An assessment of other potentially adverse conditions or areas of concern not previously identified was also performed. Methodology for this assessment was in accordance with the American Society for Testing and Materials (ASTM) Standard Guidance for Site Assessments, E 1527-94 (ASTM 1994).

SITE DESCRIPTION

The Luquillo Forest, also know as the Caribbean National Forest, is located in the northeast portion of Puerto Rico, approximately 15 km from the town of Luquillo and about 35 km from San Juan (Figure 1). The forest, occupying approximately 11,300 ha, receives up to 600 cm of rainfall annually. It is a dense evergreen forest, containing a wide variety of native flora, and is also a wildlife refuge for about 50 bird species and numerous amphibians and reptiles. The major use of the forest is ecological research; to a lesser extent, the area is also used for hiking, camping, and sight-seeing. With the exception of several principle roads and a few improved trails, the Luquillo Forest is relatively inaccessible. Interior trails are typically narrow, rugged, and steep. The El Verde Research Station was built on the site of a former coffee plantation (Figure 2), and consists of 62.4 ha located within the forest. The station is in the northwest corner of the forest and is reached via a winding, occasionally steep trail from the Field Office. The access trail is about 650 m in length and includes a cable suspension bridge over the Sonadora Creek. The main study areas were located on the northwestern slope of the mountain; other study areas were developed just up the mountain and to the east across the Sonadora River.

Four structures exist on the site. The main laboratory/office building and annex, the dormitory and dining hall, generator building, and a small storage shed. (Figure 3).

The buildings are currently used for ecological research. Researchers stay in the dormitory at the research station during the study period. The property is surrounded by rain forest, which is already under the responsibility of the USFS.

RECORDS REVIEW

DOE provided all available records regarding activities at the El Verde site for evaluation. All available direct and supporting records, reports, correspondence, and miscellaneous notes were reviewed and evaluated in order to compile a comprehensive summary of events at the site, as well as to determine the current recorded status of previously identified adverse environmental conditions. Specific environmental conditions identified and addressed to date at the El Verde site are summarized as follows.

RADIOLOGICAL

The NRC granted license # 52-19434-02 to the UPR in March 1982. The UPR performed a survey and evaluation of the facility during the years 1980 through 1983. The report indicates that the terrestrial ecology program activities at the El Verde Research Station included the use of radioactive materials for direct exposure of vegetation and for tracing biopathways. Most radionuclides used in projects were of short half-life (physical and/or biological half-life) or were in the form of sealed sources. Radionuclides reported to have been used in the study areas are H-3, P-32, Cs-134 and 137, Sr-85, Mn-54, Rb-86, and Zn-65. One 10,000 Ci sealed Cs-137 source used for an irradiation study was shipped to the U.S. in July 1966 for disposal. Radioactive materials used for labeling (tagging) vegetation have mostly decayed or dispersed to the extent that residual activity levels are at or near ambient background. Tritium was reported by UPR to be the radioisotope of concern due to the potential for incorporation into the human body. The report provided a detailed explanation regarding dissipation of tritium into the atmosphere as water vapor. Surveys were performed on interior areas, however, since the laboratory building was included in the NRC license, and plans were to use radioisotopes such as tritium, the drains, hood exhaust, and sink traps, were not included in the surveys (UPR 1983). The area surrounding the buildings was scanned and a scoping survey of the forest was also performed. Gamma surface scans and exposure rate measurements in the area surrounding the buildings indicated background levels of radionuclides. Soil sampling in the area around the buildings was not reported to have been performed. The trails from the laboratory area to the location where a sealed Cs-137 source was positioned for an irradiation experiment were surface scanned for gamma; gamma scans were also performed at 3, 6, and 12 meters from the trail. Six areas were found fenced and marked with radioactivity warnings. The six areas were mapped and surveyed, including collection of soil and vegetation samples. Contamination was identified in

Areas 4, 5, and 8. Clean-up was completed in Areas 5 and 8. The contamination in Area 4 (Figure 4) was determined to be due to residual activity remaining from an experiment involving the injection of a tree with Cs-137. Study Area 4 is located on a small knoll, slightly above the trail from the Field Office. Fencing, with postings indicating the presence of the Cs-137, previously surrounded the study area. Approximately 43 kg of contaminated soil was removed from beneath the tree leaving an estimated radiation level of 200 μR/h. Contaminated soil removed during decontamination activities was shipped to a low-level waste disposal site in Oak Ridge, Tennessee in September 1982 (UPR 1983).

Oak Ridge National Laboratory performed survey activities and reported the results as a draft report in March 1990 (ORNL 1990). These activities were conducted in an attempt to verify the previous UPR survey findings. Gamma scans of the six study areas were performed, and soil and vegetation samples were collected. All results were reported to be below the U.S. DOE guidelines for FUSRAP sites (DOE 1987) except for the contaminated tree in Area 4. The data for this Area supported the findings of the UPR survey. Further study was recommended to evaluate the areal spread and depth of the contamination, and to collect vegetation samples from the contaminated trees and the other trees in the vicinity in order to determine the potential for migration, dispersion, or secondary uptake of the contaminants. No documentation was found in the records indicating whether follow-up to this recommendation has occurred. The report gives no indication that verification scans or sampling were performed in the area immediately surrounding the buildings. Survey activities were not performed in the new laboratory section, Storage Room A in Area B, or in Shop II in Area C due to lack of records indicating historical knowledge of radioisotope usage. This report was not finalized due to budget constraints.

In February 1993, NRC renewed license #52-19434-02, amending it to allow only for storage of the Cs-137 in the tree incident to the injection experiment. In May of 1993, ORISE issued a report summarizing a review of information and results of measurements and sampling regarding the Cs-137- tagged tree in Area 4. This report indicated that potential for exposure to the public appears to be minimal and recommended either continuing the NRC license agreement, until the quantity of radioactive material could be demonstrated through survey or decay calculation to fall below the licensing level, or to perform a risk assessment and possibly terminate radiological controls.

USDA has agreed to issue a new permit to DOE limited to the one quarter acre of land on which the contaminated Cs-137 tree is located. The permit is intended to include permission to build and maintain a fence and warnings required for the site.

ASBESTOS INSPECTION

A limited asbestos investigation was performed by the Jacobs Environmental Restoration Team in May 1994, following a baseline investigation by The Oak Ridge National Laboratory Industrial Hygiene Section, in 1989 (Jacobs 1994). The Jacobs investigation followed relevant guidelines of AHERA, 40 Code of Federal Regulations (CFR) 763. Existing data was reviewed, a walk-through of each building was conducted, and bulk sampling was performed. Samples were analyzed by Schneider Laboratories, Inc. No friable asbestos-containing building materials (ACBMs) were identified on the site, and the ACBMs found were in good condition. No immediate removal recommendations were made. The ACBMs found at the site included interior and exterior transite wallboard on the Laboratory Annex. The report stated that if an effective management plan for the material was not the preferred option, portions of the facility would require significant removal of building material. Because the asbestos material is not friable, there are no current requirements for removal. DOE and USDA have agreed to manage the material in place in accordance with applicable regulations (USDA 1996).

LEAD-BASED PAINT

The final report indicated that lead-based paint was identified at three locations on door and window frames in the Dormitory Building. DOE does not plan to remove this material, however, an operating and management plan will be developed to facilitate the long term management of the material.

PCB TRANSFORMER

A letter from A. G. Caban and P. Cruz, of USDA to A. Szilagyi of DOE indicates the presence of one PCB transformer on the site. The Puerto Rico Electric Power Authority (PREPA) reviewed records regarding this transformer and found that it does not contain PCBs (PREPA 1993).

SITE RECONNAISSANCE

A site visit was performed by a DOE industrial hygienist in July, 1996. This inspection included a walk-through inspection of all buildings on the site. Results of this inspection are summarized as follows:

GENERATOR BUILDING

- Unlabeled used oil is stored in all-season coolant containers.
- No secondary containment is in place for a 550-gallon diesel fuel storage tank.
- No overfill prevention device is present on the diesel fuel storage tank. Evidence of overfill exists in the form of fuel residue on tank sides.
- The building sides are constructed of transite.
- Broken transite board was found outside of the building by the fuel tank.
- An electrical transformer was observed. It was uncertain at the time of the site visit whether the transformer contained PCBs. Subsequent information indicated that the transformer was evaluated by the Puerto Rico Electric Power Authority and found to be a non-PCB type.
- A light fixture outside of the building is not guarded.
- Electrical outlets are not protected by ground-fault-circuit-interrupters.
- A large electric breaker box on the side of the Laboratory Building adjacent to the Generator Building requires new electrical warning signage and box should be secured to control access.
- The building is not posted for noise level.

LABORATORY BUILDING AND ANNEX

- Chemical containers in several lab rooms lacked labels.
- One approximately 50 cc container was hand labeled, "contains arsenic".
- An approximately 1 liter container was marked "waste solvent".
- Flammables are not stored in a National Fire Protection Agency (NFPA) approved storage cabinet

- Laboratory electrical outlets were at "wet locations" that are not protected by ground-fault-circuit-interrupters.
- Ceiling tiles have a plastic coating on fiberglass, which may not meet NFPA requirements.
- Doors to individual labs are not equipped with door closers.
- Labs are not equipped with emergency showers or eye wash stations.

A laboratory chemical exhaust cabinet was located in one lab only. This hood was not operable due to the outlet not being served during power outages by the emergency generator, even though there were many chemicals stored in the hood. This is a tabletop hood and it is doubtful it would meet minimum flow requirements.

Utility sinks at several locations are not equipped with anti-syphoned devices. A hose was observed connected to a faucet and terminating in one of the utility sinks.

The water supply is dependent on the reservoir and is not treated. Bottled water is available, but on the day of inspection all bottled water locations were empty. All water tap locations should be posted as non-potable water.

The dehumidifier in the lecture room of the laboratory appeared to have fungal growth in the reservoir.

Exposed electrical wiring was observed in the ceiling of a room located in the laboratory annex.

STORAGE BUILDING

The Storage Building is used for storing gardening equipment. No concerns were identified in this building.

DORMITORY AND DINING HALL

Sleeping quarters have one access door for eight people with windows not accessible for escape. This may not meet NFPA 101.

The facility discharges sanitary waste to a septic tank located behind the women's sleeping quarters. No inspection or analysis of the tank or drain field was made.

FINDINGS AND CONCLUSIONS

ENVIRONMENTAL CONDITIONS

ESSAP has performed a Phase I Environmental Site Assessment of the El Verde Research Station in conformance with the scope and limitations of ASTM Practice E 1527-94. Any exceptions to, or deletions from, this practice are described in earlier sections of this report. This assessment has revealed no evidence of recognized environmental conditions in connection with the property except for the following:

Radiological

NRC license #52-19434-02, held by UPR, included Cs-137 and H-3. This license application indicates that H-3 would be handled/or stored in Laboratory II. The license was amended in February 1993 authorizing storage only of up to 1 millicurie of Cs-137 in the injected tree. Removal of the H-3 from the license would naturally deem evaluation of survey results to ensure any residual radioactivity related to these activities was satisfactorily addressed. Areas of particular interest would be sinks, drains, and hood exhausts in Laboratory II, and depending on results from these areas, possibly the septic tank and drain field. DOE indicates that no activities involving radioactive materials were conducted in or around the laboratories. Radioactive materials are reported to have been received in the quantities necessary for the studies and then applied directly to the study area, without the need for preparation activities. It is recommended that a more complete history of activities related to radioactive materials use in the laboratory be obtained from personnel who performed work on the site. Soil sampling was not recorded to have been performed in the area surrounding the buildings during either the UPR survey or the ORNL survey activities. When an NRC license is terminated, confirmatory sampling is routinely performed to ensure the final status of a site is acceptable for release for unrestricted use. DOE plans to restore the security fencing and warning signs around the contaminated tree.

Asbestos

The asbestos identified during the Jacobs inspection will not be removed. DOE indicates plans to develop an operating and management plan for this material.

Lead-Based Paint

The lead-based paint identified from sample analysis will not be removed. DOE indicates plans to develop an operating and management plan for this material.

Other Hazardous Materials

If no future activities will require use of hazardous materials, these materials, such as used oil, waste solvent, and chemicals should be removed from the site. If future use is anticipated, the facility would be considered "conditionally exempt" and would require an Environmental Protection Agency (EPA) generator number.

Diesel Fuel Tank

Evidence of overfill of the diesel fuel tank was observed. Sampling would be required in order to evaluate the potential for contamination in the surrounding area. If the tank is to be reactivated, an overfill protection device should be installed.

SAFETY AND HEALTH CONDITIONS

The following concerns are not considered "environmental conditions" per the guidance document, however, they are considered to be significant safety and/or health issues which should be addressed:

Electrical Concerns

Electrical fixtures and outlets are not up to current standards. A complete electrical evaluation would be required to determine the extent of upgrade to the electrical system that would be necessary to meet all current electrical codes.

Potential Noise Hazard

Measurement of the noise level in the Generator Building is recommended prior to work taking place in the area.

Fire Code Concerns

Flammables are not stored properly. All such materials should be stored in NFPA-approved storage cabinets.

Ceiling tiles with plastic coating on fiberglass should be evaluated for compliance with NFPA requirements.

Access to sleeping quarters which meets NFPA 101 requirements must be established prior to use.

Concerns for Future Operation of Laboratories

Should laboratories become operational, the lab doors should be equipped with door closers, emergency showers, and eye wash stations.

Hoods containing chemicals must have a source of power which is maintained during power outages. Hoods must also be checked to ensure minimum flow requirements are met.

Sinks in laboratories must be equipped with anti-syphoning devices to ensure that liquids cannot be drawn into the clean water supply. Sinks must also be marked as having a non-potable water supply.

The septic system should be evaluated.

General Concerns for Individuals Working in the Buildings

A supply of potable water must be available at all times.

The dehumidifier must be cleaned and maintained if it is to be used.

SUMMARY

The Environmental Survey and Site Assessment Program of ORISE performed a Phase I Environmental Site Assessment of the El Verde Research Station in the Luquillo Forest, Luquillo, Puerto Rico. Assessment activities included historical record reviews and an evaluation of the results from a site inspection performed by DOE.

The assessment identified three environmental conditions and several general safety and health conditions.

Environmental conditions included incomplete documentation in the historical records to determine whether radioactive materials were used in the laboratories, presence of hazardous materials on the site without record of an EPA conditionally exempt generator number, and evidence of overfill in the area surrounding the diesel fuel tank.

Safety and health conditions identified at the site included the existence of a potential noise hazard in the Generator Building, fire code concerns, and multiple concerns related to any future operation of the laboratories and conditions for laboratory workers.

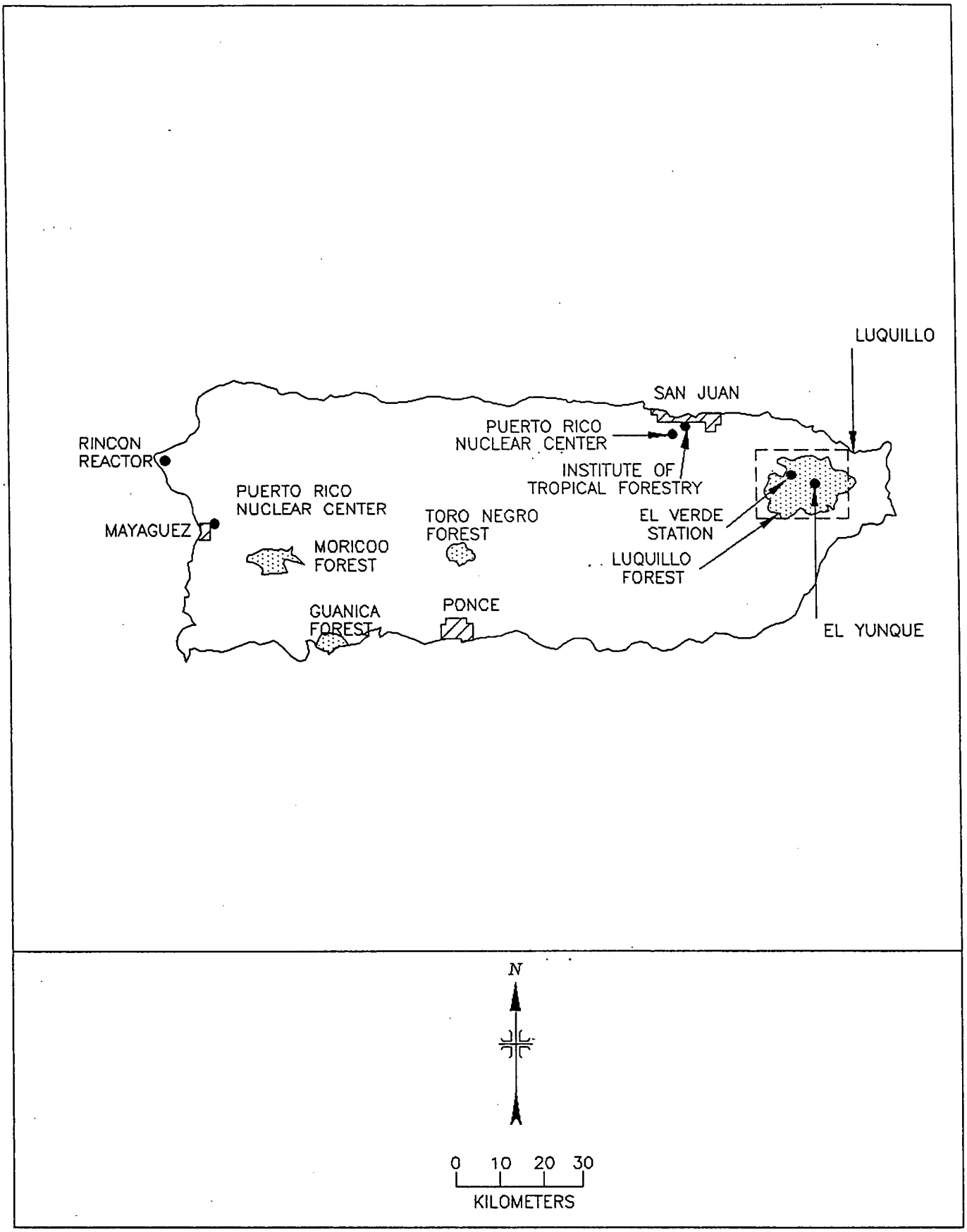

FIGURE 1: Map of Puerto Rico – Location of Luquillo Forest and El Verde Research Area (From "Radiological Survey Report for El Verde Research Station," CEER-X-115, Health and Safety Division, CEER, May 1983, Revised)

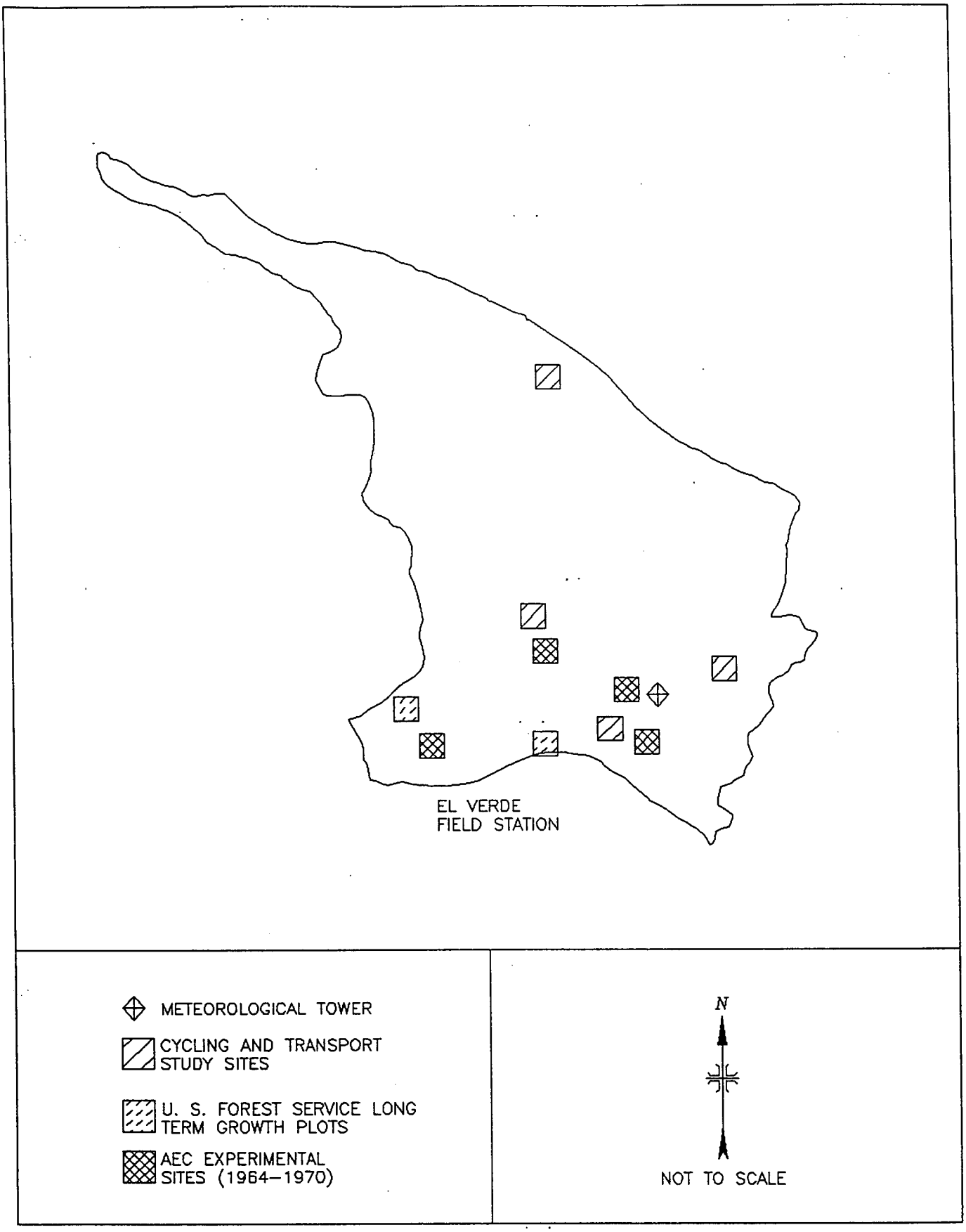

FIGURE 2: Approximate Boundary of the 156 Acres Under DOE-Forest Service Agreement

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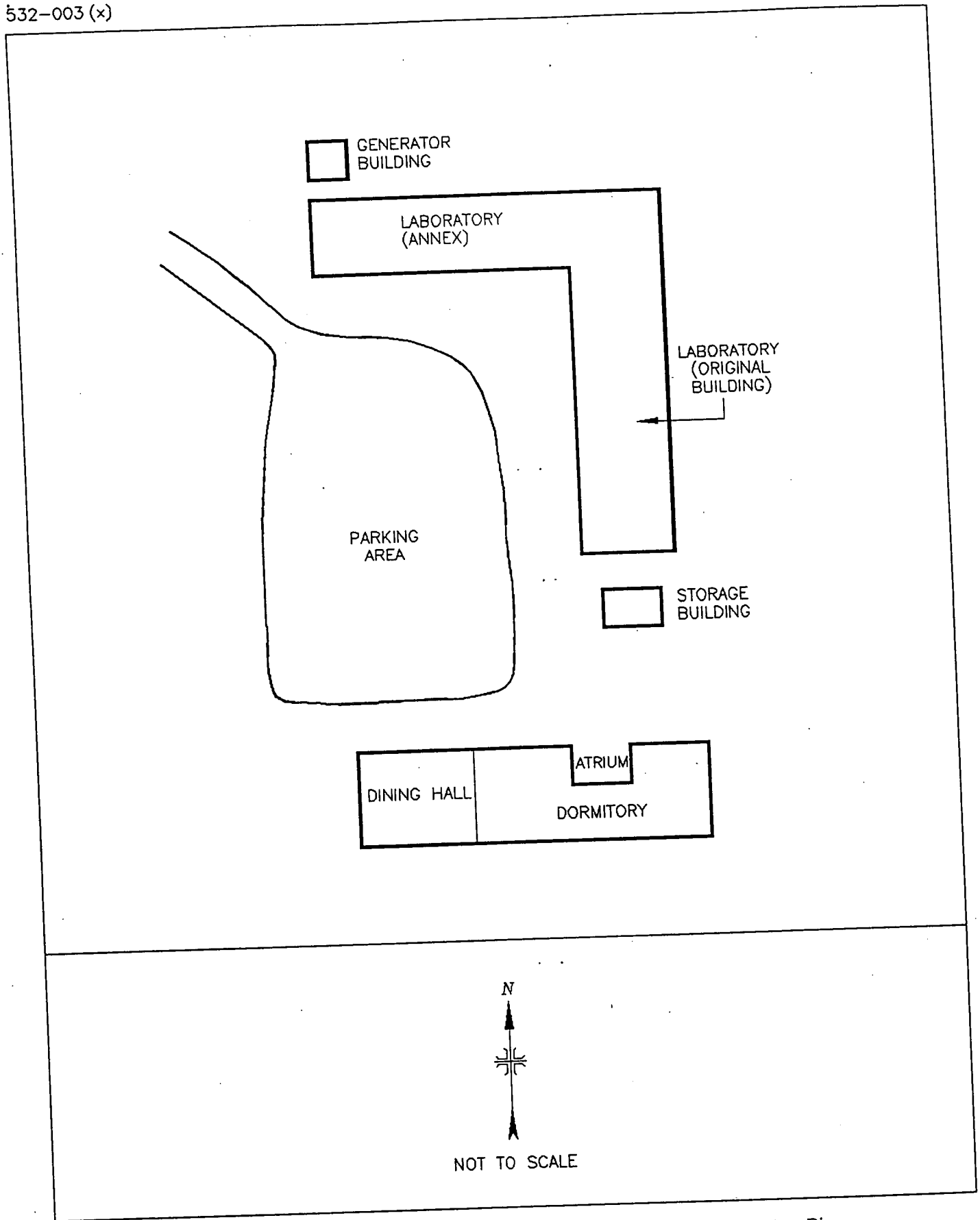

FIGURE 3: El Verde CEER Facility – El Verde, Puerto Rico

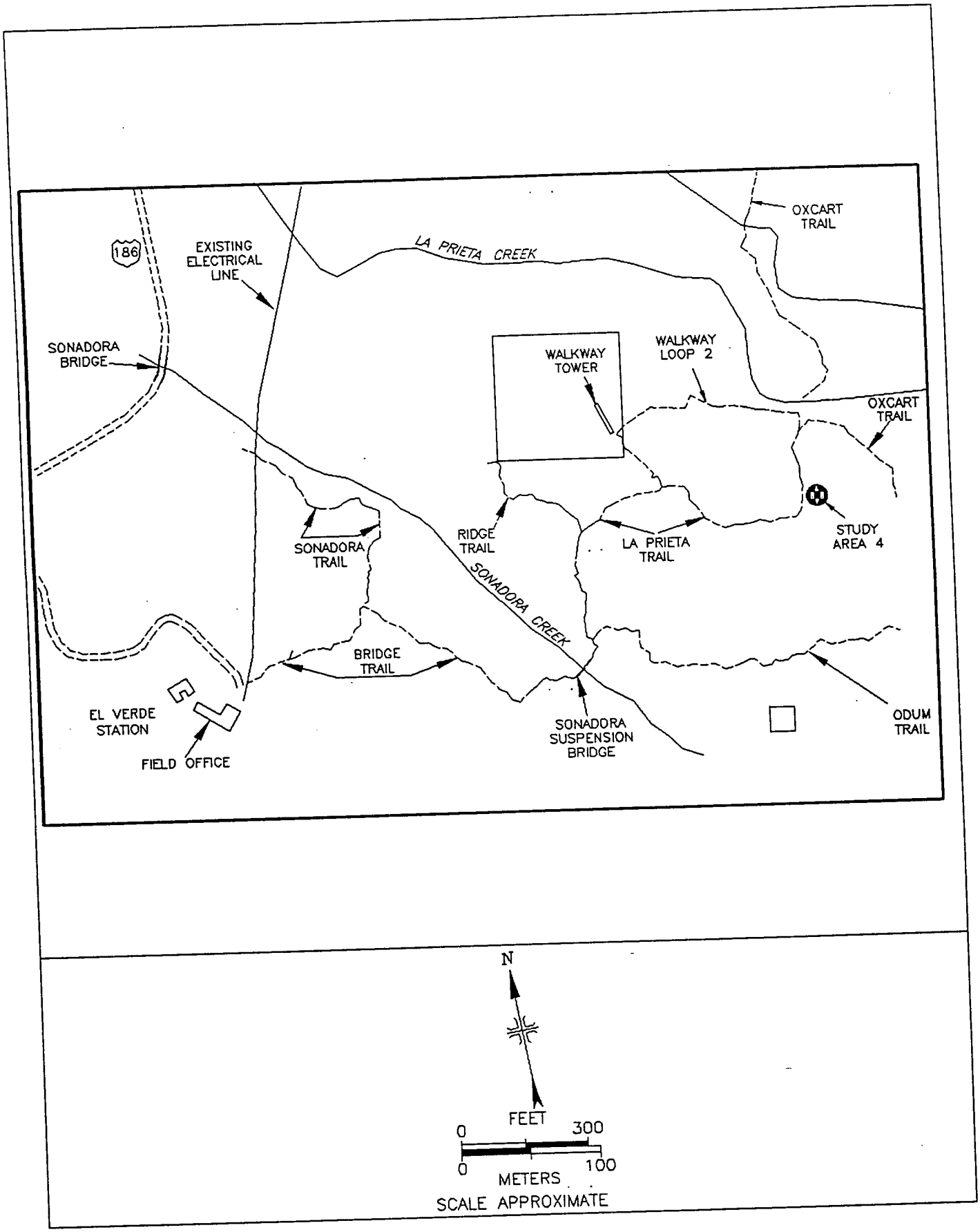

FIGURE 4: El Verde Research Station. – Location of Cesium–137–Labeled Tree in Study Area 4

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Asbestos Inspection Report
for the
Center for Energy and Environment Research Facilities
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Prepared by
Jacobs ER Team
125 Broadway Avenue
Oak Ridge, Tennessee
under contract DE-AC05-93OR22028

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CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ACBM	asbestos-containing building material
ACM	asbestos-containing material
ACT	acoustical ceiling tile
AHERA	Asbestos Hazard Emergency Response Act
CEER	Center for Energy and Environment Research
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
NAD	no asbestos detected
NESHAP	National Emission Standards for Hazardous Air Pollutants
NVLAP	National Voluntary Laboratory Accreditation Program
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PLM	polarized light microscopy
RACM	regulated asbestos-containing materials
TSI	thermal system insulation
USDA	United States Department of Agriculture

EXECUTIVE SUMMARY

In support of the U.S. Department of Energy (DOE) Decontamination and Decommissioning Program, the Jacobs Environmental Restoration Team conducted a limited asbestos inspection of building and miscellaneous materials at the Center for Energy and Environment Research (CEER) facility in El Verde, Puerto Rico. This facility is slated for transfer to the U.S. Department of Agriculture (USDA).

The El Verde Research Facility was assessed in 1989 by Oak Ridge National Laboratory (ORNL) Industrial Hygiene Section. Information from the earlier inspections provided a baseline of conditions at the facility. The current inspections verified the baseline and provided a comprehensive report on the asbestos-containing building materials (ACBMs) at the facility.

This inspection followed applicable regulations of the Asbestos School Hazard Abatement Reauthorization Act, which require use of inspectors accredited under the Model Accreditation Program (MAP) when inspecting public or commercial buildings. This U.S. Environmental Protection Agency (EPA)-approved certification also educates the inspector in the regulations of the National Emission Standards for Hazardous Air Pollutants as it relates to the renovation and removal of ACBMs. The MAP stipulates that certified inspectors use the Asbestos Hazard Emergency Response Act protocol when identifying and assessing suspect homogeneous materials.

The inspection was conducted on May 19, 1994. Five bulk asbestos samples were collected and sent to Schneider Laboratories of Richmond, Virginia, an accredited National Voluntary Laboratory Accreditation Program laboratory. During the assessment, a field data sheet was compiled on each building, and ACBMs were assessed and sampled based on the homogeneity of the materials.

The general conclusions of the inspection are that the El Verde Research Facility has only one ACBM in the transite panels of the laboratory annex building. These panels are in the interior and exterior walls. The recommended plan for this facility is long-term management of the ACBM. Based on the current conditions, the ACBM's within the laboratory annex can be managed throughout the life of the building. Before the demolition of the building, the ACBMs would require proper and safe removal. If removal is required, the majority of the laboratory annex would be stripped of building materials.

2. OBJECTIVE

DOE intends to identify the current uses of ACBMs, their condition and potential hazards, abatement opportunities, and the potential for the long-term management of ACBMs before conveyance of the facility. This report identifies the interim goals for the remaining ACBMs.

The report provides a general description of the buildings and equipment surveyed, information about the various ACBM forms present, their location, and recommended actions. Although this inspection did not reveal additional ACBMs, it documented the absence or removal of previously identified ACBMs.

The AHERA protocol was used as a guide for survey and sampling techniques. The survey emphasized diligence and followed reasonable and prudent investigative techniques. However, this limited asbestos survey report does not certify, guarantee, imply, or otherwise warrant that any or all structures and equipment associated with the facilities are "asbestos-free."

3. SURVEY PROTOCOL

The survey followed relevant guidelines of AHERA [40 *Code of Federal Regulations* (CFR) 763] to the greatest extent possible. After a review of existing data and drawings, a walk-through of each building was conducted to identify and group suspect materials and potential sampling locations. Each building was measured, other building construction materials were identified, and current and possible future uses were noted. Nonfriable materials were evaluated for long-term management.

The bulk sampling strategy was based on the type of suspect material [i.e., thermal system insulation (TSI), surfacing, or miscellaneous] to be sampled and the homogeneity of the material. For the purposes of the survey, a homogeneous area or unit contains material that is the same color or texture and appears to have been installed at the same time. The suspect materials were sampled by collecting more than one sample of the homogeneous material in random locations. To reduce sampling cost, existing data from previous inspections were incorporated into the overall sampling scheme.

Once a homogeneous area or unit was identified, a field data sheet was completed by noting the building, its unique number (i.e., ELV-02, etc.), a description of material, estimated quantity of material, friable vs nonfriable condition, samples collected, and other pertinent data. Appendix A contains these field data sheets. Sampling locations may be identified or cross-referenced by using field data sheets, sketches, the sample log, and laboratory analytical data sheets.

3.1 SAMPLE COLLECTION

The following step-by-step procedures were used in the collection of each bulk sample:

1. The individual collecting the sample wore appropriate personal protective equipment including a full-face, air-purifying respirator and gloves.

2. A water mist was applied to the surface of each suspect material.

3. A sample was extracted using a single-edged knife, ensuring that all layers of the suspect material were included in the sample.

requires the assessment of friable ACBMs only, this inspection assessed all material forms in terms of overall condition, functionality, and potential for damage. Categories of significantly damaged, damaged, or good condition were used.

3.4 REGULATORY COMPLIANCE

The management of ACBMs at the CEER facility are not regulated by AHERA. The prime regulatory driver for this project is the National Emission Standards for Hazardous Air Pollutants (NESHAP). Within 40 CFR 61, the renovation or demolition projects of regulated asbestos-containing materials (RACM) must meet the specified provisions of the regulations. The NESHAP asbestos rule identifies RACMs in various categories for materials that contain more than one percent asbestos by PLM analysis. The categories are:

- friable asbestos material;
- Category I: nonfriable ACM that has become friable;
- Category I: nonfriable ACM that will be or has been subjected to abrasive (i.e., sanding, grinding, cutting, etc.) removal techniques; and
- Category II: nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by demolition activities.

A Category I, nonfriable ACM includes packing, gaskets, resilient floor covering, and asphalt roofing products containing more than one percent asbestos. A Category II ACM contains more than one percent asbestos that, when dry, cannot be reduced to powder by hand pressure.

Some of the main provisions of the NESHAP demolition and/or renovation rule include:

- Mandatory asbestos building inspections are required prior to renovation or demolition activities.
- Materials must be adequately wet, a provision for preventing the release of visible emissions ("if visible emissions are observed coming from the ACM, then that material has not been adequately wetted").

4. INSPECTOR CERTIFICATION AND LABORATORY ACCREDITATION

This survey was performed by a Jacobs ER Team AHERA-certified asbestos inspector and management planner, as stipulated in the Model Accreditation Plan of AHERA and in compliance with the Asbestos School Hazard Abatement Reauthorization Act of 1990. However, the procedures mandated under AHERA only apply to public and private schools (K-12). Therefore, although AHERA does not apply to this survey, the protocol employed uses relevant guidelines and procedures of AHERA. A copy of the inspector's current registration is provided in Appendix D.

Each building was evaluated separately and suspect homogeneous materials were either sampled or assumed to be ACBMs. Samples collected were sent to Schneider Laboratory in Richmond, Virginia, a National Voluntary Laboratory Accreditation Program (NVLAP)-accredited laboratory. A copy of their certificate of accreditation is provided in Appendix C.

5. SITE DESCRIPTION

The El Verde research site is located within the northern perimeter of the Caribbean National Forest, approximately 30 miles southeast of San Juan (see Figs. 1 and 2). This CEER facility consists of older structures (circa 1950s) and newer buildings, such as the laboratory annex and dinning hall. The majority of the buildings are concrete since wood (organic) materials decompose rapidly within the tropical environment. The facility is currently used for forestry research projects. It consists of a main laboratory building, annex, shop area, dormitory, newly constructed dining hall, generator building, and small metal storage shed. Each building is discussed separately in Chapter 6.

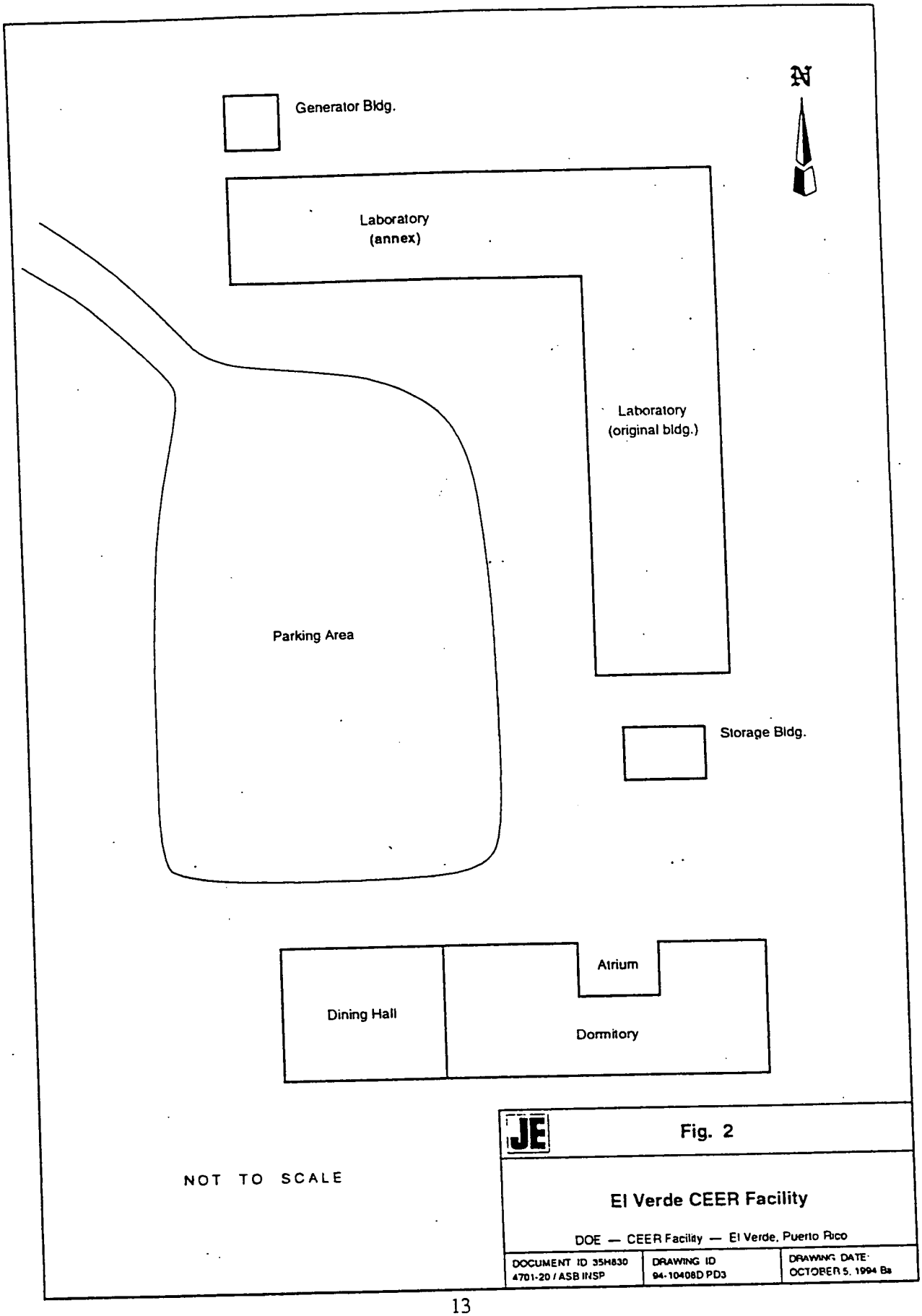

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Fig. 2

El Verde CEER Facility

DOE — CEER Facility — El Verde, Puerto Rico

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6. SURVEY DATA

This section describes each building that was surveyed, the homogeneous materials or units identified, and analysis results for collected samples.

Building descriptions include the approximate dimensions of the structure, estimated quantity of ACBMs, and a listing of the observed building materials. The buildings surveyed are in alphabetical order within this section.

Material or units are identified or assessed based on their homogeneity within each building as well as across the site. Suspect materials are either sampled or assumed to be ACBM based on material knowledge (i.e., exterior transite wall panels).

The data analysis sections summarize the results of the sampling. Since some homogeneous areas may lack sufficient data or sample collection points from the previous surveys, this survey focused on bridging data gaps, providing adequate sample representation, and investigating materials that were not previously identified.

Since no friable ACBMs were identified, an imminent hazard analysis which identifies the condition of the material, potential for disturbance, fiber release scenario, and the recommended action was not required.

Table 1 summarizes the analytical data generated during this inspection. Comprehensive discussion is provided in the "Conclusions" and "Recommendation" sections of this report. Appendix A provides a data sheet on each building with suspect materials and a schematic indicating sampling locations. Refer to Appendix B for the photo documentation of the homogeneous materials and sampling locations. Appendix E contains the analytical data sheets provided by the laboratory.

6.1 EL VERDE RESEARCH SITE

Refer to Figure 2 for a site plan for this facility.

Table 1. Data analysis summary for El Verde, Puerto Rico site

Sample Number	Date	Building	Material Type (see legend below)	Sample Color	% Asbestos	Asbestos Type
ELV-01-01	5/19/94	Generator Building	Suspect transite	Beige	NAD	N/A
ELV-02-01	5/19/94	Laboratory Annex	Interior wall board	Gray	25	Chrysotile
ELV-02-02	5/19/94	Laboratory Annex	Interior wall insulation	Yellow	NAD	N/A
ELV-02-03	5/19/94	Laboratory Annex	Interior wall board	Beige	30	Chrysotile
ELV-03-01	5/19/94	Laboratory Annex	Floor tile mastic *	Brown/Black	<1	Chrysotile

* Asbestos in mastic only

ELV = El Verde
NAD = no asbestos detected
N/A = not applicable

6.1.1 Generator Building

This building measures approximately 9 × 9 × 12 ft and currently houses the emergency generator for the facility. This building was rebuilt during renovation efforts in the late 1980s.

6.1.1.1 Homogeneous areas/units

Fibrous wallboard was used in the construction of the side walls of this building. Although the building was renovated or rebuilt in recent years, the material still remains suspect. Sample ELV-01-01 represents this fibrous, nonfriable wallboard.

6.1.1.2 Data analysis

In the 1989 survey, the Generator Building was identified as having ACBM wall panels. Recent renovations have removed these materials and replaced them with a hard, fibrous paneling. The analysis of the material indicates no asbestos fibers and a composition of cellulose fiber and nonfibrous materials.

According to site personnel, the asbestos transite panels that were used in the original construction of the walls and roof were removed. The details and/or proof of this removal is not available for this report.

6.1.2 Dormitory

The dormitory is irregularly shaped, approximately 90 ft long and 50 ft wide. This is an original structure and is over 30 years old. It was built with wooden materials, but a thick coating of plaster or concrete has been used to fully encapsulate the interior and exterior surfaces.

6.1.2.1 Homogeneous areas/units

The plaster material was in good, sound condition and did not appear to be a suspect material. However, prior to any demolition, further evaluation, including collection of samples, is required. No samples were collected from this building.

6.1.3 Dining Hall

This newly constructed building is adjacent to the dormitory and is approximately 12 by 30 ft. Concrete is the primary building material used. No suspect ACBM was observed.

6.1.3.1 Homogeneous areas/units

No suspect ACBMs were noted in the dining hall.

6.1.4 Main Laboratory/Office Building

The main laboratory and office building is approximately 125 by 40 ft and is constructed of concrete; the floor, walls, and roof are constructed of concrete. No suspect materials were noted.

6.1.4.1 Homogeneous areas/units

No suspect ACBMs were noted in this building.

6.1.4.2 Laboratory annex

This addition to the main laboratory/office building measures approximately 75 by 25 ft. It is used for office space and for biology and ecological laboratories where no major analytical tests are performed. There are no laboratory hoods in use nor piping for gas and steam. This annex does, however, have asbestos transite panels on the exterior of the building. This information was documented in previous inspections. Asbestos warning signs are currently posted on the exterior panels. A drop ceiling is present with suspect interior wall partitions. Floor tiles were noted and appeared new and homogenous throughout the building.

6.1.4.3 Homogeneous areas/units

The interior walls, which divide the floor space into offices, are composed of a nonfriable, fibrous matrix material. Sample collection of this material was very difficult using a single-edged razor knife. Two samples (ELV-02-01 and ELV-02-03) were collected from this material. A fibrous insulation was found between the wall partitions; sample ELV-02-02 represents this material. The floor tiles were installed in the late 1980s and should not have any asbestos composition; however, sample ELV-03-01 was collected, which included the mastic material. The ceiling tiles were not considered suspect material due to their recent installation. Site personnel conveyed that the material was not ACBM.

6.1.4.4 Data analysis

Analysis of the suspect materials within the annex revealed that the interior wallboard contained 25–30 percent chrysotile asbestos. Also, the exterior walls of the laboratory annex are constructed of asbestos transite panels. These exterior panels were labeled as ACBM.

Precautions should be taken prior to physically disturbing the material. The paneling materials, both inside and outside, are nonfriable and may be easily maintained through implementation of a management plan.

Analysis shows that the insulation used behind the interior wallboard is not a fibrous material and is most likely composed of a synthetic material. The floor tile is vinyl, and the mastic (adhesive) material has an asbestos content of less than one percent.

7. CONCLUSIONS

This section summarizes the ACBM types found at the facility. It also integrates the data generated during previous inspections with the present analysis. Buildings having suspect ACBM are identified below and all relevant information known on the ACBMs, their condition, and potential for disturbance is summarized.

7.1 GENERATOR BUILDING

In 1989 Oak Ridge National Laboratory (ORNL) surveyed the buildings associated with the El Verde Site. The building materials associated with the Generator Building were assumed to be ACBMs. Corrugated panels on the roof and the wall construction were not documented. Since the 1989 inspection, the generator has been rebuilt and the ACBMs were properly disposed of according to site personnel. Evidence or records of this removal were not available for this survey. Sampling of the fiber board during this survey indicated that the material is not an ACBM.

7.2 LABORATORY ANNEX

In 1989, bulk asbestos samples were collected from floor tiles, ceiling tiles, wallboard, and roofing materials from the Laboratory Annex. The asbestos content in all samples was below detection levels with the exception of the wallboard. Confirmation samples collected show that the wallboard is asbestos-containing, is nonfriable, and has low potential for disturbance with the proper administrative controls. The floor tiles and mastic contained less than 1 percent asbestos; therefore they are nonregulated materials.

8. RECOMMENDATIONS

As stated earlier, recommendations will be provided for ACMs found at the facility. Factors considered are friability, potential for use, current material assessment, and potential for future damage and possible fiber releases. This section does not discuss each building separately, but provides a feasible approach for each ACBM identified. Table 2 lists each building surveyed, identifies ACBM present and existing conditions, estimated square footage of the material, and the recommended action.

8.1 SHORT-TERM RECOMMENDATIONS

Since there were no friable ACBMs on the site and the ACBMs that were present were in good condition, there are no immediate removal or interim removal recommendations for this site.

8.2 LONG-TERM MANAGEMENT RECOMMENDATIONS

The ACBMs found at the site include interior and exterior transite wallboard on the Laboratory Annex. These materials were in good condition, non-friable, and can be managed-in-place throughout the life of the building. The use of an asbestos management plan is recommended for this site. Also, even though the mastic under the floor tile contained less than 1 percent asbestos, this material should also be considered as a suspect material. However, floor tile and mastic usually do not require frequent maintenance.

Under the auspice of an effective management plan, the laboratory annex can be maintained in the current condition. If this option is not preferred, the laboratory annex would require significant removal of building materials.

8.3 MANAGEMENT PLAN REQUIREMENTS

A management plan generally includes provisions for identifying responsible party(ies), operations and maintenance, and periodic surveillance in accordance with the Model Accreditation Program. The survey report findings should be incorporated into the management plan. Administrative and engineering controls should be identified in the plan with a point of contact for each facility. The management plan addresses all aspects of asbestos management to ensure that employees, building occupants, and the public are not exposed to asbestos.

Table 2. Summary of findings and recommendations for El Verde, Puerto Rico site

Sample Number	Building	Material Type	% Asbestos	Condition#	Estimated Quantity*	Removal Priority**
ELV-01-01	Generator building	Suspect transite	NAD	N/A	N/A	N/A
ELV-02-01	Laboratory Annex	Interior wall board	25	NR-Good	160 ft^3	3
ELV-02-02	Laboratory Annex	Interior wall insulation	NAD	N/A	N/A	N/A
ELV-02-03	Laboratory Annex	Interior wall board	30	NF-Good	160 ft^3	3
ELV-03-01	Laboratory Annex	Floor tile mastic *	<1	NF-Good	1875 ft^2	3

NF = non-friable
* Units based on material type.
** 1 = immediate, 2 = secondary, 3 = long-term management.
ELV = El Verde
N/A = not applicable with no ACBM
NAD = no asbestos detected

Periodic surveillance by facility personnel responsible for the plan can monitor the condition of the ACBMs and formally provide documentation of the surveillance every six months. Periodic surveillance is usually conducted by custodial or maintenance staff and will be the responsibility of the owner and operator. Under AHERA protocol, a reinspection is required following a response action (or other activity) that may alter the condition of the ACBMs or every three years, whichever comes first.

The primary function of the management plan is to provide a site-specific operations and maintenance program. At a minimum the operations and maintenance program should include recommendations for labeling ACBMs; notification of building occupants; training requirements for in-house personnel; employee protection and medical surveillance programs; work practices for initial cleaning, maintenance, and renovation activities; a work permit system to minimize inadvertent contact with ACBMs; procedures for addressing fiber release episodes; guidelines for periodic surveillance; and procedures for recording operations-and-maintenance-related activities. These requirements are the criteria for an AHERA management plan. Even though the CEER facilities do not have to comply with AHERA, these requirements should be considered and incorporated when practical.

APPENDIX A

Homogeneous Materials Information

HOMOGENOUS MATERIALS INFORMATION

Homogenous Material Number: 02

Site: El Verde

Building: Lab Annex

Inspector: G. Hopper

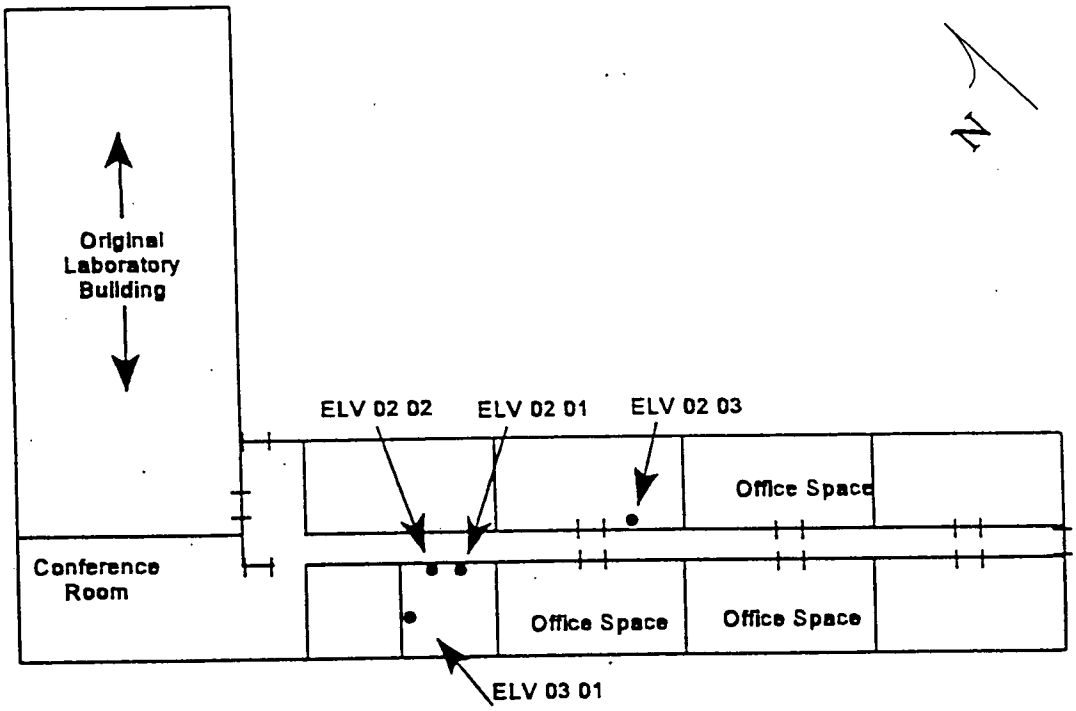
Date: May 19, 1994

Material Description: (1 & 3) Fibrous, hard interior wall board used in annex to divide office space. (2) Insulation between interior boards. (03-01) Floor tile and mastic.

Quantity: Wallboard total = 160 ft.^{3}
Floor tile = 1,875 ft.^{2}

Friable: ( ) Yes (X) No

Sample Location: See diagram below



Sample Numbers: ELV-02-01, ELV-02-02, ELV-02-03, ELV-03-01

Comments: Exterior wall board assumed ACBM.

HOMOGENOUS MATERIALS INFORMATION

Homogenous Material Number: 01

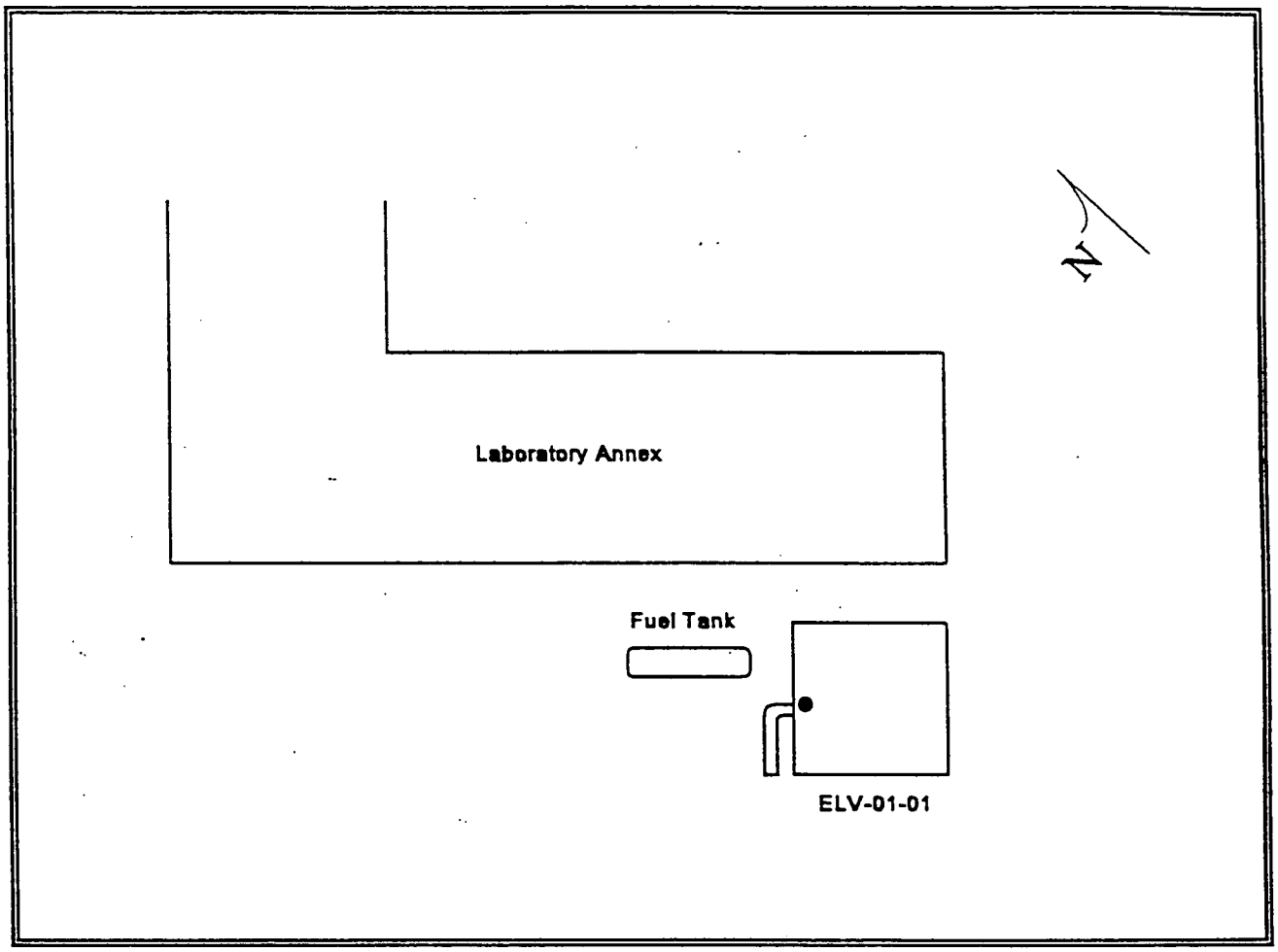
Site: El Verde Building: Generator Building

Inspector: G. Hopper Date: May 24, 1994

Material Description: Suspect transite panels (fiber board).

Quantity: 100 ft^2 Friable: ( ) Yes (X) No

Sample Location: At vent pipe opening near AST.



Sample Numbers: ELV-01-01

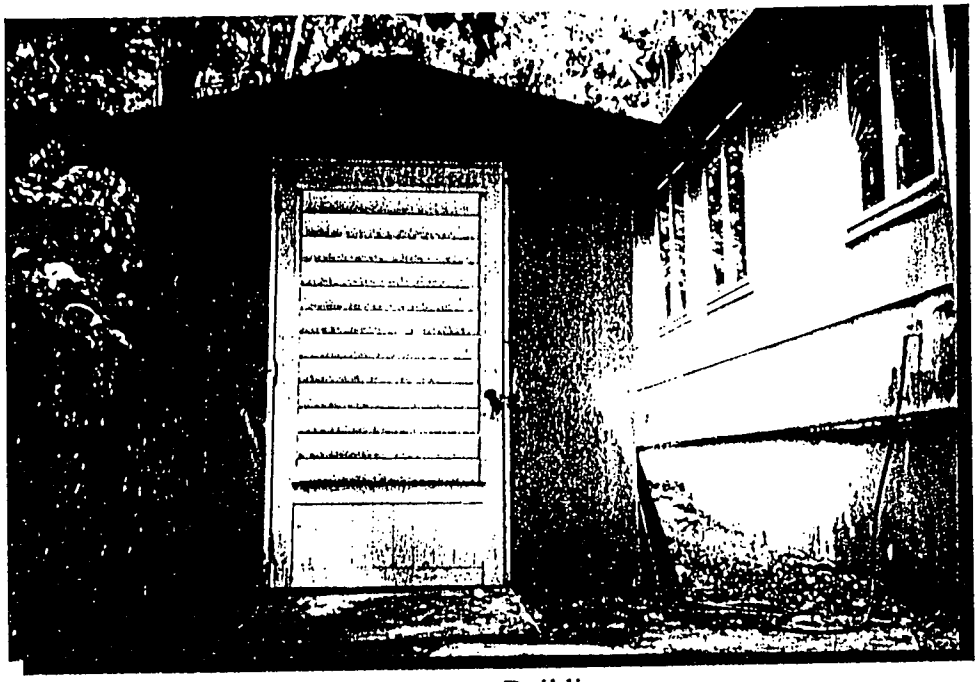
Comments: Building has been rebuilt and asbestos panels were removed. Replacement fiberboard was sample to verify composition.

APPENDIX B

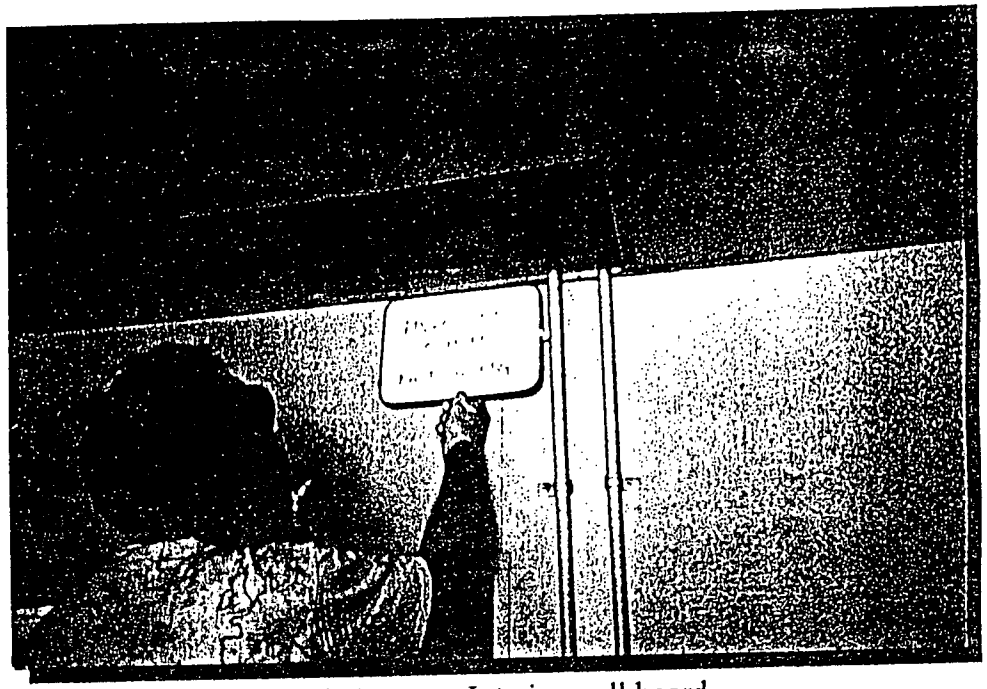
Photo Documentation

Lab Annex - Interior wall partitions

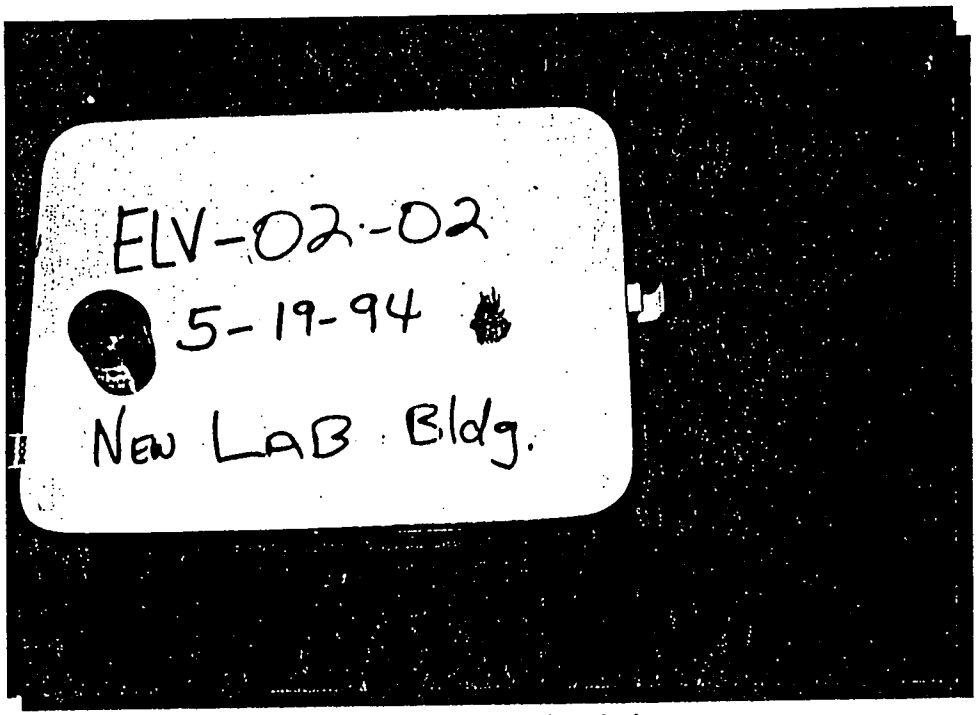
Lab Annex - Floor tile



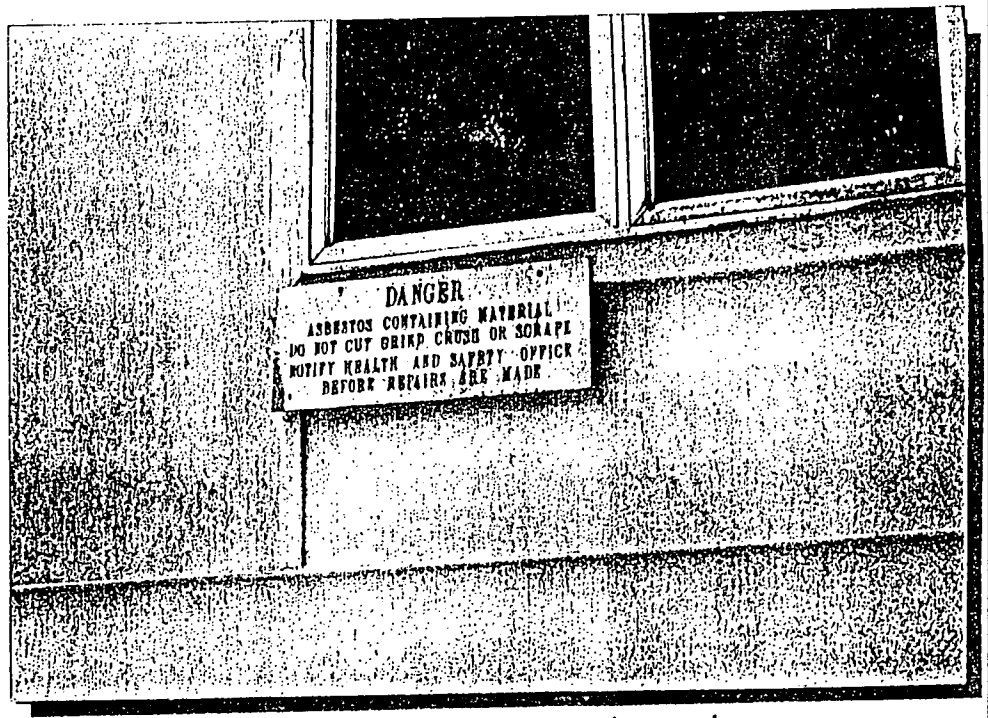
Generator Building



Lab Annex - Interior wall board



Lab Annex - Wall insulation



Lab Annex - Exterior transite panels

APPENDIX C

Schneider Laboratory's Certificate of Accreditation

National Institute of Standards and Technology

NVLAP

National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION

NVLAP LAB CODE 1150

BULK ASBESTOS FIBER ANALYSIS

Schneider Laboratories, Inc.
104 Berrington Court
Richmond, VA 23221-2702
Raja F. Abouzaki Phone: 804-353-6778

Accreditation Renewal Date: April 1, 1995

NVLAP Code	*Designation*
18/A01	40 Code of Federal Regulations Chapter I (1-1-87 edition) Part 763, Subpart F, Appendix A or the current U. S. Environmental Protection Agency method for the analysis of asbestos in building materials by polarized light microscopy.

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA •

For the National Institute of Standards and Technology

United States Department of Commerce
National Institute of Standards and Technology

NVLAP

Certificate of Accreditation

SCHNEIDER LABORATORIES, INC.
RICHMOND, VA

is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations. Accreditation is awarded for specific services, listed on the Scope of Accreditation, for:

BULK ASBESTOS FIBER ANALYSIS

April 1, 1995
Effective until

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA •

For the National Institute of Standards and Technology

APPENDIX D

AHERA Inspector Certification

The Environmental Institute

Guy Hopper

Has completed coursework and satisfactorily passed an examination that meets all criteria required for the EPA/AHERA-Approved Reaccreditation Course and NESHAPs Regulations

Asbestos in Buildings: Inspector and Management Planner Refresher

August 3, 1993
Course Date

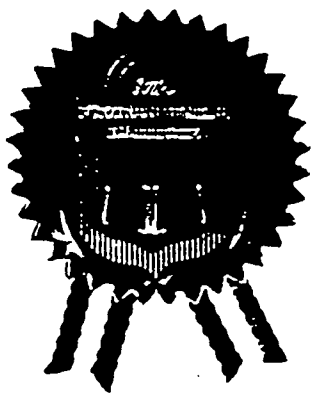
August 3, 1993
Examination Date

August 2, 1994
Expiration Date

William H. Spain
Course Director

Exam Administrator

3884-A
Certificate Number



4501 Circle 75 Parkway, Suite C-3100 - Atlanta, GA 30339 - (404) 952-8794

* This meets Illinois requirements

APPENDIX E

Laboratory Data Sheets

SCHNEIDER LABORATORIES, INC.
104 BERRINGTON CT.
RICHMOND, VA 23221-2702
(804) 353-6778

ASBESTOS IDENTIFICATION REPORT
(BY EPA INTERIM METHOD)
(40 CFR 763, SUBPT F, APP. A)

CLIENT: JACOBS ENGINEERING
125 BROADWAY
OAKRIDGE, TN 37830

WORK ORDER NO: 446-94- 2
ACCOUNT NO: 446
P.O.: 35-H830-47Q94-0275
PROJECT: EL VERDE
EL VERDE

THE SAMPLE(S) SUBMITTED FOR ASBESTOS BULK ANALYSIS HAVE BEEN COMPLETED. THEY WERE ANALYZED BY POLARIZED LIGHT MICROSCOPY WITH DISPERSION STAINING. THE RESULTS ARE AS FOLLOWS:

LAB ID NO	FIELD ID	SAMPLE LOCATION	SAMPLE COLOR	HOMOGENEOUS	PERCENT ASBESTOS
550353-94	ELV-01-01	GENERATOR BLDG.	BEIGE	YES	*NAD
ASBESTOS TYPES:					
OTHER MATERIAL: CELLULOSE FIBER 30% NON FIBROUS MATERIAL 70%					
550354-94	ELV-02-01	LAB ANNEX	GRAY	YES	25%
ASBESTOS TYPES: CHRYSOTILE 25%					
OTHER MATERIAL: CELLULOSE FIBER 5% NON FIBROUS MATERIAL 70%					
550355-94	ELV-02-02	LAB ANNEX	YELLOW	YES	*NAD
ASBESTOS TYPES:					
OTHER MATERIAL: NON FIBROUS MATERIAL 100%					

REMARKS: DETECTION LIMIT: LESS THAN 1% ASBESTOS; *NAD-NO ASBESTOS DETECTED

ANALYST: CHRISTIE K BUIE

DATE OF ANALYSIS: 06/20/94

R. VANCE, Ph.D., CIH

AMMENED REPORT

SCHNEIDER LABORATORIES, INC.
104 BERRINGTON CT.
RICHMOND, VA 23221-2702
(804) 353-6778

ASBESTOS IDENTIFICATION REPORT
(BY EPA INTERIM METHOD)
(40 CFR 763, SUBPT F, APP. A)

PAGE:

CLIENT: JACOBS ENGINEERING
125 BROADWAY
OAKRIDGE, TN 37830

WORK ORDER NO: 446-94- 2
ACCOUNT NO: 446
P.O.: 35-H830-47Q94-0275
PROJECT: EL VERDE
EL VERDE

THE SAMPLE(S) SUBMITTED FOR ASBESTOS BULK ANALYSIS HAVE BEEN COMPLETED. THEY WERE ANALYZED BY POLARIZED LIGHT MICROSCOPY WITH DISPERSION STAINING. THE RESULTS ARE AS FOLLOWS:

LAB ID NO	FIELD ID	SAMPLE LOCATION	SAMPLE COLOR	HOMOGENEOUS	PERC ASBES
550356-94	ELV-02-03	LAB ANNEX	BEIGE	YES	30%

ASBESTOS TYPES: CHRYSOTILE 30%
OTHER MATERIAL: CELLULOSE FIBER 5% NON FIBROUS MATERIAL 65%

550357-94	ELV-03-01	LAB ANNEX	BROWN/BLACK	YES	<1%

ASBESTOS TYPES: CHRYSOTILE <1%
OTHER MATERIAL: CELLULOSE FIBER 5% NON FIBROUS MATERIAL 95%
ASBESTOS PRESENT IN MASTIC ONLY

REMARKS: DETECTION LIMIT: LESS THAN 1% ASBESTOS; *NAD-NO ASBESTOS DETECTED

ANALYST: CHRISTIE K BUIE

DATE OF ANALYSIS: 06/20/94

R. VANCE, Ph.D., CIH
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY ACCREDITATION REQUIREMENTS MA
DATE THAT THIS REPORT MUST NOT BE REPRODUCED EXCEPT IN FULL WITH THE APPROVA
OF THE LABORATORY. THIS REPORT RELATES ONLY TO THE ITEMS TESTED.

NBS SIGNATORY: _____

If the submitted materials are regulated by the EPA NESHAP (National Emissio
Standards for Hazardous Air Pollutants) and have an asbestos content of les
than 10% by visual estimation, reanalysis by point count method or TEM (Tra
mission Electron Microscopy) is recommended. Both services are available at
additional charge.

ORNL/RASA–90/1

PRELIMINARY SITE SURVEY REPORT OF THE EL VERDE RESEARCH STATION, CENTER FOR ENERGY AND ENVIRONMENT RESEARCH,

IN THE LUQUILLO FOREST, LUQUILLO, PUERTO RICO (PRE001)

R. D. Foley
L. M. Floyd

DRAFT

ORNL/RASA-90/1

HEALTH AND SAFETY RESEARCH DIVISION

Waste Management Research and Development Programs
(Activity No. AH 10 05 01 0; EW202001)

PRELIMINARY SITE SURVEY REPORT OF THE EL VERDE RESEARCH STATION, CENTER FOR ENERGY AND ENVIRONMENT RESEARCH, IN THE LUQUILLO FOREST, LUQUILLO, PUERTO RICO (PRE001)

R. D. Foley and L. M. Floyd

Date of Issue – March 16, 1990

Investigation Team

R. E. Swaja – Measurement Applications and Development Manager
W. D. Cottrell – Project Director
R. D. Foley – Field Survey Supervisor

Survey Team Members

J. A. Foley
N. E. Irizarry*

*Center for Energy and Environment Research

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted a preliminary radiological survey at the El Verde Research Station, Center for Energy and Environment Resaerch, in the Luquillo Forest, Luquillo, Puerto Rico (PRE001), in 1988. The purpose of the survey was to determine whether the site was contaminated with radioactive residues from project sponsored in the 1960s by the Atomic Energy Commission and the U. S. Department of Agriculture, Forest Service. The scope of this preliminary survey primarily covered the six main outdoor study areas (2–5, 7, and 8) and the old laboratory building areas A, B, and C. The survey included gamma scans, indoors and outdoors; direct measurements of alpha radiation levels and transferable measurements of beta–gamma radiation levels, indoors; and soil and vegetation sampling for radionuclide analyses.

Results of the survey demonstrated radionuclide concentrations in excess of the current DOE criteria for ^{137}Cs in soil at study area 4. Based on the results of this radiological assessment, it is recommended that a follow-up, detailed radiological survey of both surface and subsurface environs be performed to more precisely define the extent of the contamination from possible radionuclide migration and areal spread of ^{137}Cs in study area 4.

PRELIMINARY SITE SURVEY REPORT OF THE EL VERDE RESEARCH STATION, CENTER FOR ENERGY AND ENVIRONMENT RESEARCH, IN THE LUQUILLO FOREST, LUQUILLO, PUERTO RICO (PRE001)*

INTRODUCTION

In the early 1960s, the Atomic Energy Commission (AEC) sponsored the development of the Puerto Rico Nuclear Center (PRNC), near San Juan, Puerto Rico (Fig. 1), launching a comprehensive program for research and training in nuclear science and engineering, with applications of nuclear energy in medicine, agriculture, and industry.[1] In 1964, AEC and the U. S. Department of Agriculture, Forest Service (USFS) signed a memorandum of agreement, separating 156 acres of the Luqillo Forest (the El Verde Rain Forest) into an experimental area for the El Verde Research Station (EVRS), shown in Fig. 1.

In 1976, PRNC became the Center for Energy and Environment Research (CEER), and control transferred from the Energy Research and Development Administration (ERDA), formerly AEC and presently the U. S. Department of Energy (DOE), to the University of Puerto Rico (UPR), terminating the agreement with USFS. UPR placed responsibility for EVRS under CEER and continued use of the EVRS area under permit from USFS.

The main study areas (2–5, 7, and 8) were located on the northwestern side of the Rain Forest, with the research station built on the site of a former coffee plantation (Fig. 2). A plot plan of the laboratory building and residence is shown in Fig. 3. The AEC and USFS conducted detailed ecological studies in this area on radioactive fallout in tropical forests and on the effects of sealed, point sources of ^{60}Co and ^{137}Cs. These gamma emitting point sources were later removed, and several study areas were developed east of the Sonadora River for researching the subsequent mineral cycling and forest metabolism (Fig. 4). The follow-up studies used ^{134}Cs, ^{137}Cs, ^{56}Fe, ^{3}H, ^{54}Mn, ^{32}P, ^{86}Rb, ^{75}Se, ^{85}Sr, and ^{65}Zn as radiotracers. Designated areas of vegetation and/or soil were either sprayed or injected with the tracers. Access to these areas was controlled by fencing and dog patrols.

The first investigative survey and decontamination of the EVRS buildings and study areas were performed by the Health and Safety Division of CEER and reported in 1983.[1] A later survey of study area 4 by the USFS was reported to CEER by correspondence in 1989.[2] The letter discussed continuing ^{137}Cs contamination above background levels in two trees in that area.

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*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

Because the contamination reported by USFS was apparantly related to AEC activities, verification of these findings was needed to determine whether the site met current radiological guidelines, then, if necessary and appropriate, to correct these conditions. The principal radionuclide of concern is ^{137}Cs and its naturally occurring decay products.

On June 14 and 15, 1989, the preliminary radiological survey at the EVRS site was conducted by a member of the Measurement Applications and Development Group of the Oak Ridge National Laboratory at the request of DOE. Outdoor surveys of study areas 2–5, 7, and 8 are shown in Figs. 5 through 10. Soil and vegetation samples were taken for further analyses during that time. Indoor surveys for the old section of the laboratory building, areas A–C, are shown in Figs. 11 through 13. Smear samples were also taken from the laboratory for assessment.

SURVEY METHODS

The radiological survey of the EVRS site included: (1) outdoor gamma scans of six study areas 2–5, 7, and 8, and (2) collection of surface soil and vegetation samples; as well as (3) indoor gamma scans of the old laboratory areas A–C, and (4) direct alpha and transferable beta–gamma activity levels in the laboratory areas. No exterior surveys were performed around the immediate buildings. Three indoor laboratory areas were not surveyed: the new section, a storage room A in area B, and shop II in area C. The new section of the laboratory was constructed in 1976, and no records were found of radioisotope usage in this area. The storage room A and shop II were filled with vegetation samples and stored equipment. The survey methods followed the basic plan outlined in a correspondence from W. D. Cottrell to A. J. Whitman.[3]

Using a portable Victoreen gamma scintillation meter, ranges of measurements were recorded in all six study areas and inside the old section of the laboratory. (Gamma values are given in $\mu R/h$.) The detector was held approximately three inches above the ground surface or floor. If the gamma levels were elevated, a biased sample was taken near the point showing the highest gamma radiation level. Systematic samples were taken at various locations outdoors, irrespective of gamma radiation levels. Soil samples taken outdoors from 0 to 15 cm in depth. One vegetation sample was taken from study area 8. Soil and vegetation samples were analyzed for all gamma emitting radionuclides, with results reported for ^{137}Cs, ^{232}Th, and ^{238}U content. In addition, samples were collected from areas 2 and 3 for analysis of ^{3}H content.

Indoors, direct alpha activity levels were determined using a Geiger–Müller (GM) pancake type probe with an alpha scintillation meter. Smears from 100 cm^2 areas were obtained from various surfaces in the three old laboratory areas to establish transferable beta–gamma activity levels. All samples were handled through the appropriate signed Quality Assurance chain of custody and transported to Tennessee under permit to Oak Ridge Associated Universities (ORAU). ORAU followed the U. S. Department of Agriculture's requirements for soil sterilization, etc., and then returned the samples to ORNL. Comprehensive descriptions of all survey methods and instrumentation have been presented in another report.[4]

SURVEY RESULTS

Applicable DOE guidelines are summarized in Table 1.[5 and 6] These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in soil and vegetation samples. Transferable radioactivity levels (smears) are reported as net counts with background subtracted.

Outdoor Survey Results

Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan at each of the six study areas (2–5, 7, and 8) are given in Figs. 5 through 10. Gamma exposure rates over the major portions of five study areas (2, 3, 5, 7, and 8) ranged from 2 to 3 μR/h. Study area 4 measured 2 to 14 μR/h on the perimeter but contained two trees with elevated gamma levels (Fig. 7). Both trees had previously been injected with ^{137}Cs. Tree #1 measured 15 μR/h at the base of the tree, 10 μR/h at the injection site of 1.5 m above ground, 9 μR/h at 2 m of elevation, and 170 μR/h at the bottom of a partially excavated hole under this tree. Biased soil sample 4B1 was taken from this excavated hole. Tree #2 measured 5 μR/h both at its base and 1 m above ground. No other elevated levels were discovered in any of the study areas.

Systematic and Biased Soil Samples

Systematic soil samples were taken for radionuclide analyses from various locations at each of the six study areas. As mentioned above, one biased soil sample was taken from the hole beneath tree #1 in area 4 (Fig. 7). Locations of the systematic (S) and biased (B) samples are shown in Figs. 5 through 10, with results of analytical assessment provided in Table 2. Concentrations of cesium, thorium, and uranium in the systematic samples ranged from 0.29 to 2.53 pCi/g, 0.22 to 0.35 pCi/g, and 0.67 to 1.60 pCi/g, respectively. Concentrations of cesium, thorium, and uranium in the biased sample were 370 pCi/g, 0.29 pCi/g, and 2.96 pCi/g, respectively. None of the soil samples were above DOE guideline values (Table 1), with the possible exception of biased sample 4B1 for cesium.

Soil samples (2S1, 2S2, and 3S1) from study areas 2 and 3 were also analyzed for the radionuclide, tritium. All three samples contained minimal concentrations for ^{3}H of less than 1.35 pCi/g. With the exception of ^{137}Cs and ^{134}Cs, none of the isotopes used for injections or spraying were detected in any of the soil samples. Soil sample 4B1 was the only sample with elevated ^{137}Cs. Samples 5S2 and 8S1 contained very low but detectable concentrations of the ^{134}Cs, with values of 1.35 pCi/g and 0.66 pCi/g, respectively.

Vegetation Sample

One vegetation sample (V) was taken from study area 8, near the fence on the western side of the enclosure, as shown in Fig. 10. In Table 2, concentrations of cesium, thorium, and uranium for this sample (8V1) were 1.10 pCi/g, 0.56 pCi/g, and 8.41 pCi/g.

Indoor Survey Results

Gamma Radiation Levels

Gamma radiation levels measured during a scan of the floor inside the old laboratory building areas A, B, and C are given in Figs. 11 through 13. Gamma exposure rates generally ranged from 2 to 5 μR/h in all three areas; none were elevated.

Alpha and Beta–Gamma Measurements

Measurements of direct and transferable radioactivity levels were taken from floor surfaces in each of the three laboratory areas A, B, and C (Figs. 11 through 13). All 21 direct alpha measurements were below the minimum detectable amount (MDA) of <30 dpm/100 cm^2. Twenty one smear samples were obtained from the same three areas A, B, and C. Analyses of the smears showed all measurements of transferable beta–gamma radiation from a 100–cm^2 area were below the MDA of 120 dpm.

SIGNIFICANCE OF FINDINGS

Measurements and results of soil and vegetation sample analyses taken at EVRS, Puerto Rico indicate that the property contained elevated levels of ^{137}Cs, found at study area 4 and possibly migrating from the base of one previously injected tree. Biased soil sample (4B1) was taken from under this tree and contained 370 pCi/g of ^{137}Cs; its location is shown in Fig. 7. The concentrations of all other radionuclides on this site were below applicable DOE criteria (Table 1) and basically in agreement with the findings reported by N. E. Irizarry, CEER–X–115.[1]

RECOMMENDATIONS

Based on the results of this radiological assessment, it is recommended that a follow-up, detailed radiological survey of study area 4 be performed to:

- determine the areal spread of ^{137}Cs (if any),
- determine the depth of possible contaminant migration,
- take vegetation samples from the trees in question to determine leaf content and estimate annual dispersion, and
- take samples from other vegetation in the vicinity to determine secondary uptake.

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1. N. E. Irizarry and A. V. Cruz, *Radiological Survey Report for El Verde Research Station, Center for Energy and Environment Research,* Health and Safety Division, University of Puerto Rico, CEER–X–115 (Rev. May 1983).

2. A. E. Lugo, U. S. Department of Agriculture, Forest Service, Rio Piedras, PR, to N. E. Irizarry, Center for Energy and Environment Research, Health and Safety Division, Mayaguez, PR, correspondence in reply to 1350 (March 7, 1989).

3. W. D. Cottrell, ORNL, to A. J. Whitman, DOE/HQ, correspondence, "Radiological Survey of Private Properties in Lodi, New Jersey" (August 15, 1984).

4. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).

5. U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Rev. 2, March 1987).

6. Nuclear Regulatory Commission, *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By--Product, Source, or Special Nuclear Material* (May 1987).

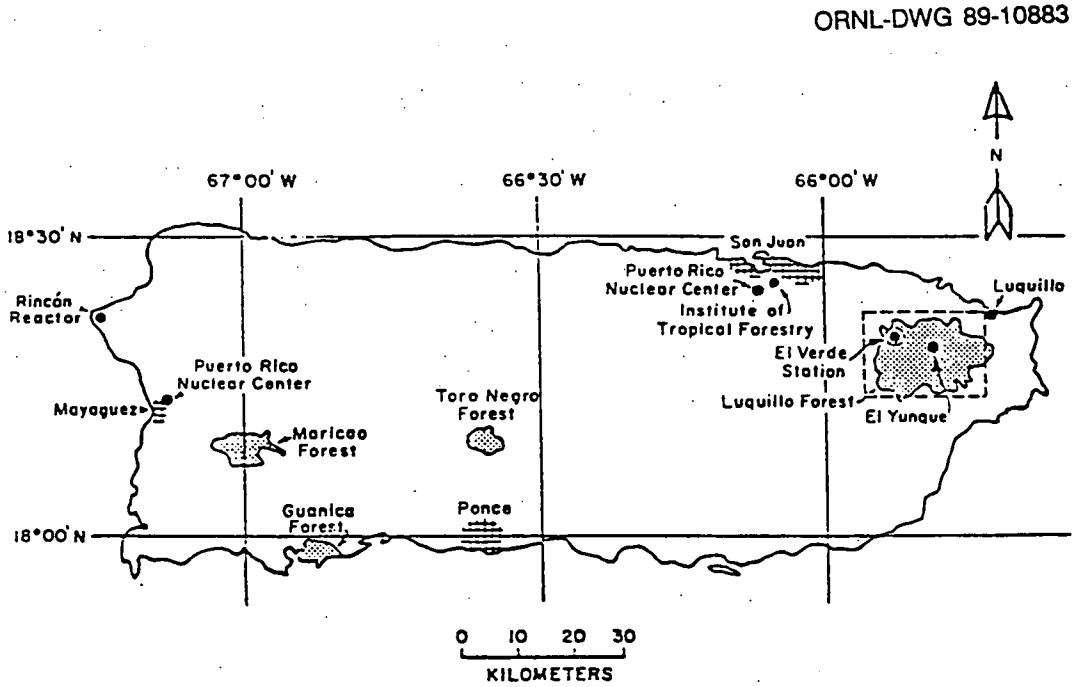

Fig. 1. Map of Puerto Rico showing the locations of EVRS, Luquillo Forest, and PRNC. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

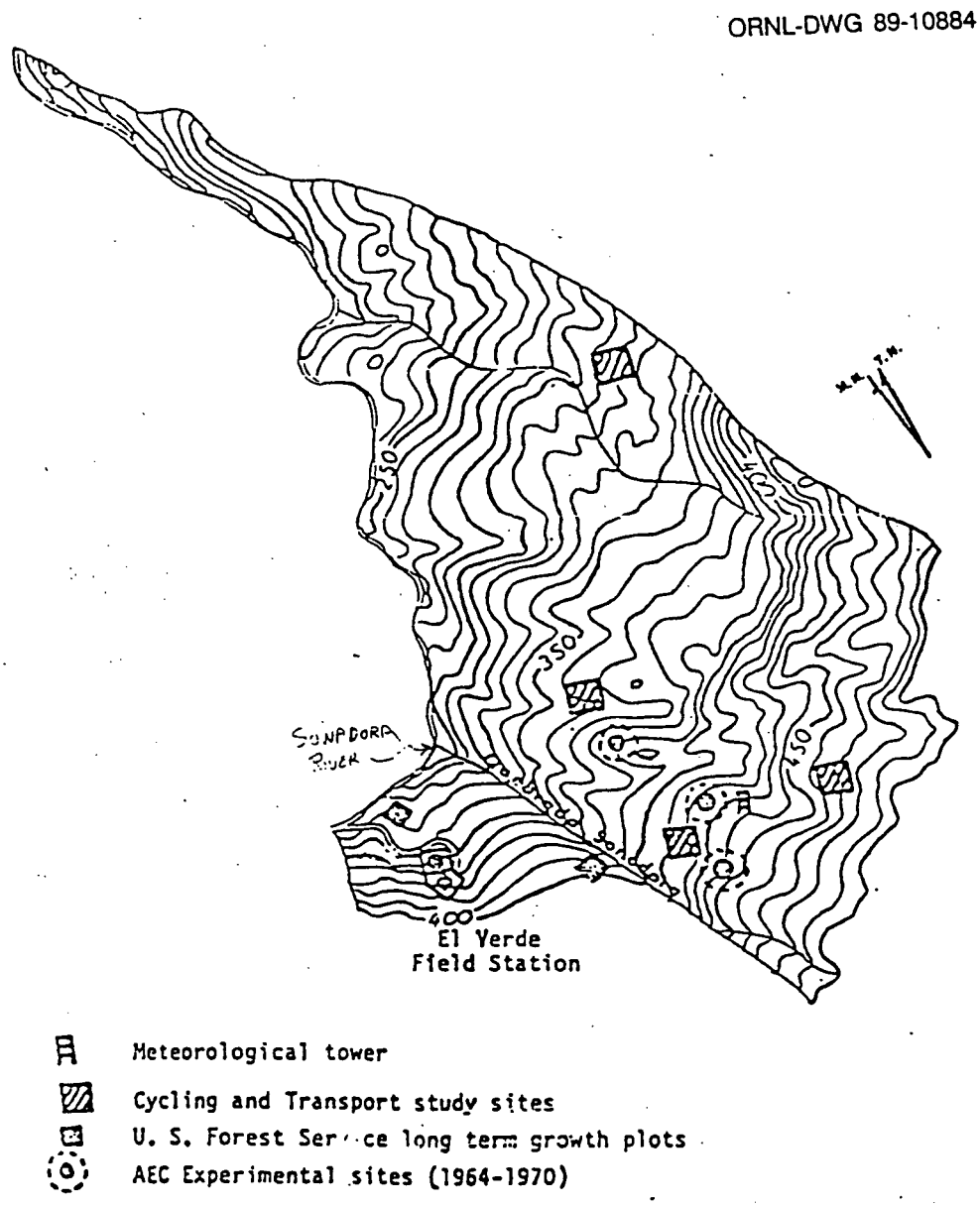

Fig. 2. Approximate boundaries to the 156 acres of the EL Verde Rain Forest allocated to EVRS, Puerto Rico (PRE001). (Figures are duplicated from an earlier report by N. E. Irizarry, CEER-X-115.[1])

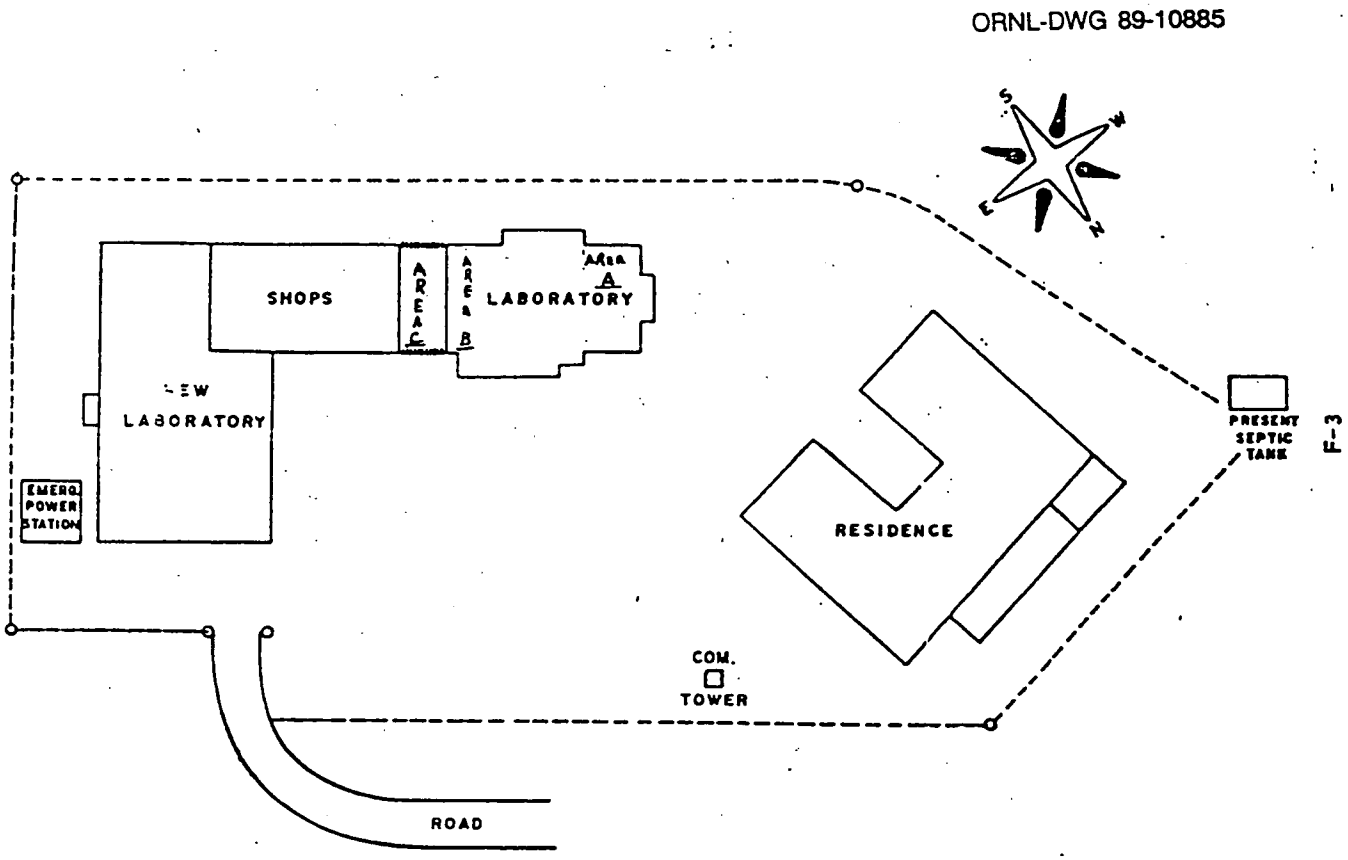

Fig. 3. Plot plan of the laboratory building and residence at EVRS, Puerto Rico (PRE001). (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

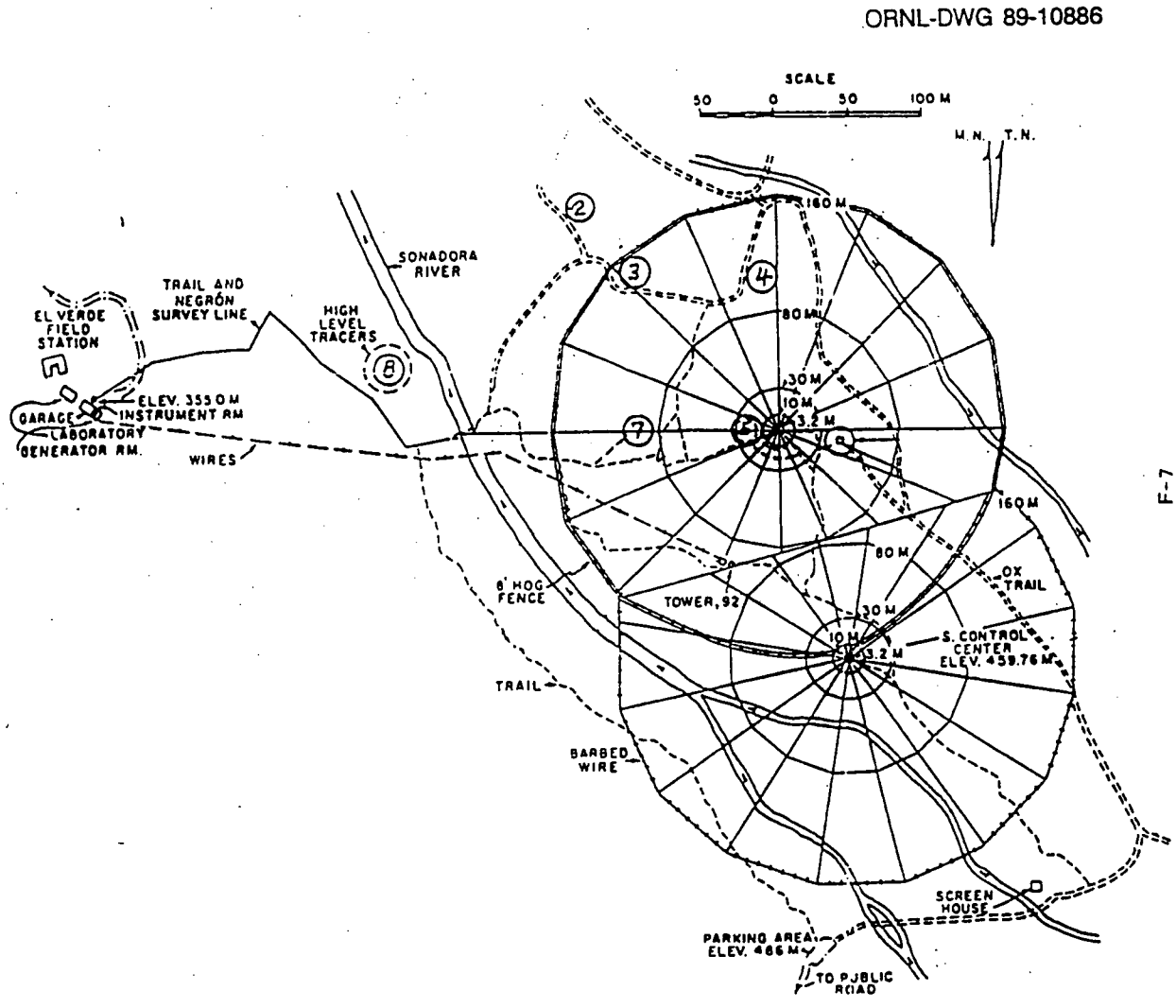

Fig. 4. Diagram showing the six study areas surveyed at EVRS, Puerto Rico (PRE001). Numbered circles show the locations of the six radiotracer sites surveyed. The 160–m radii show the approximate radiation centers for the point source sites of ^{137}Cs. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

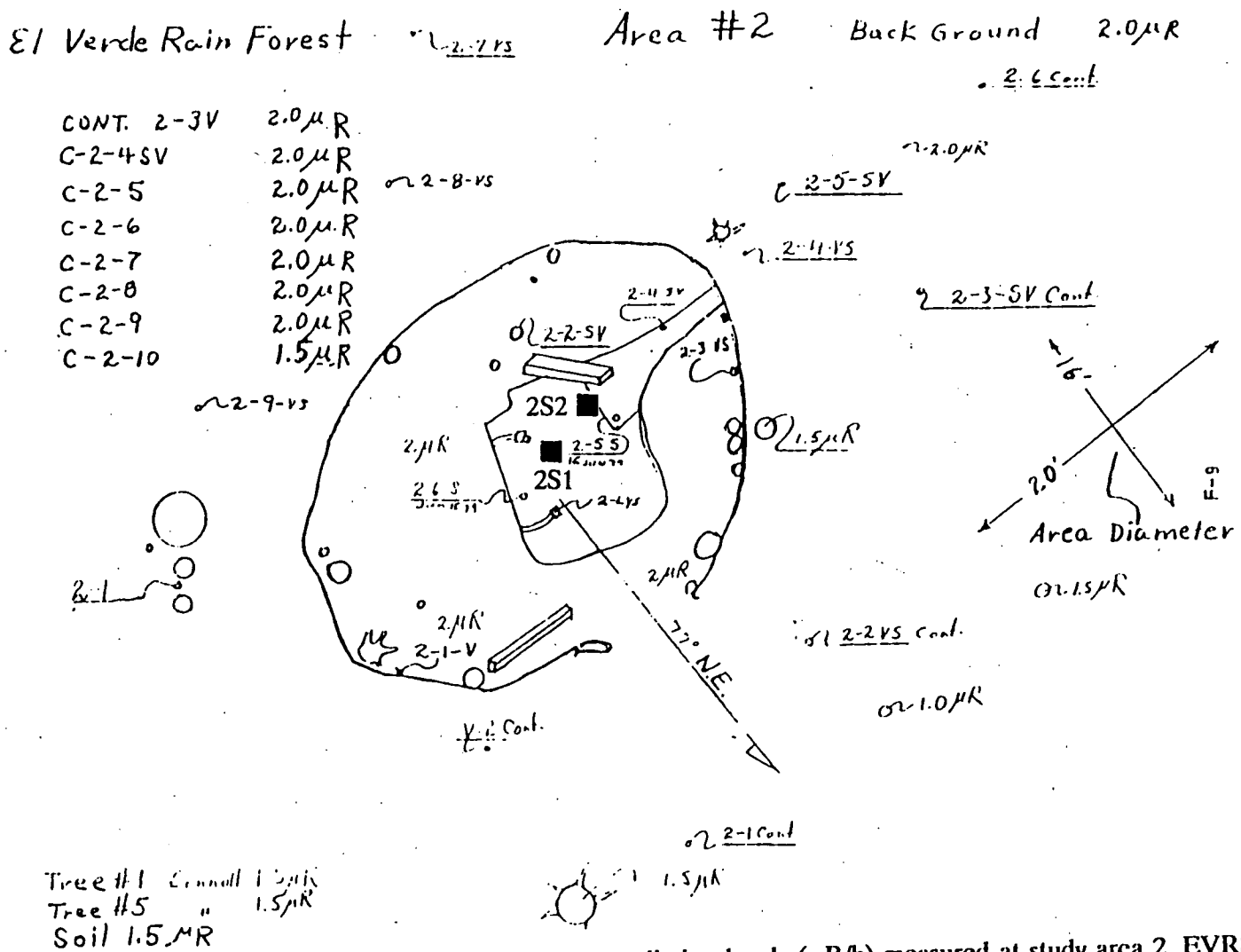

Fig. 5. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 2, EVRS, Puerto Rico (PRE001), and locations of ORNL soil sampling (■). ORNL gamma scan range was 2 to 3 μR/h. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER-X-115.[1])

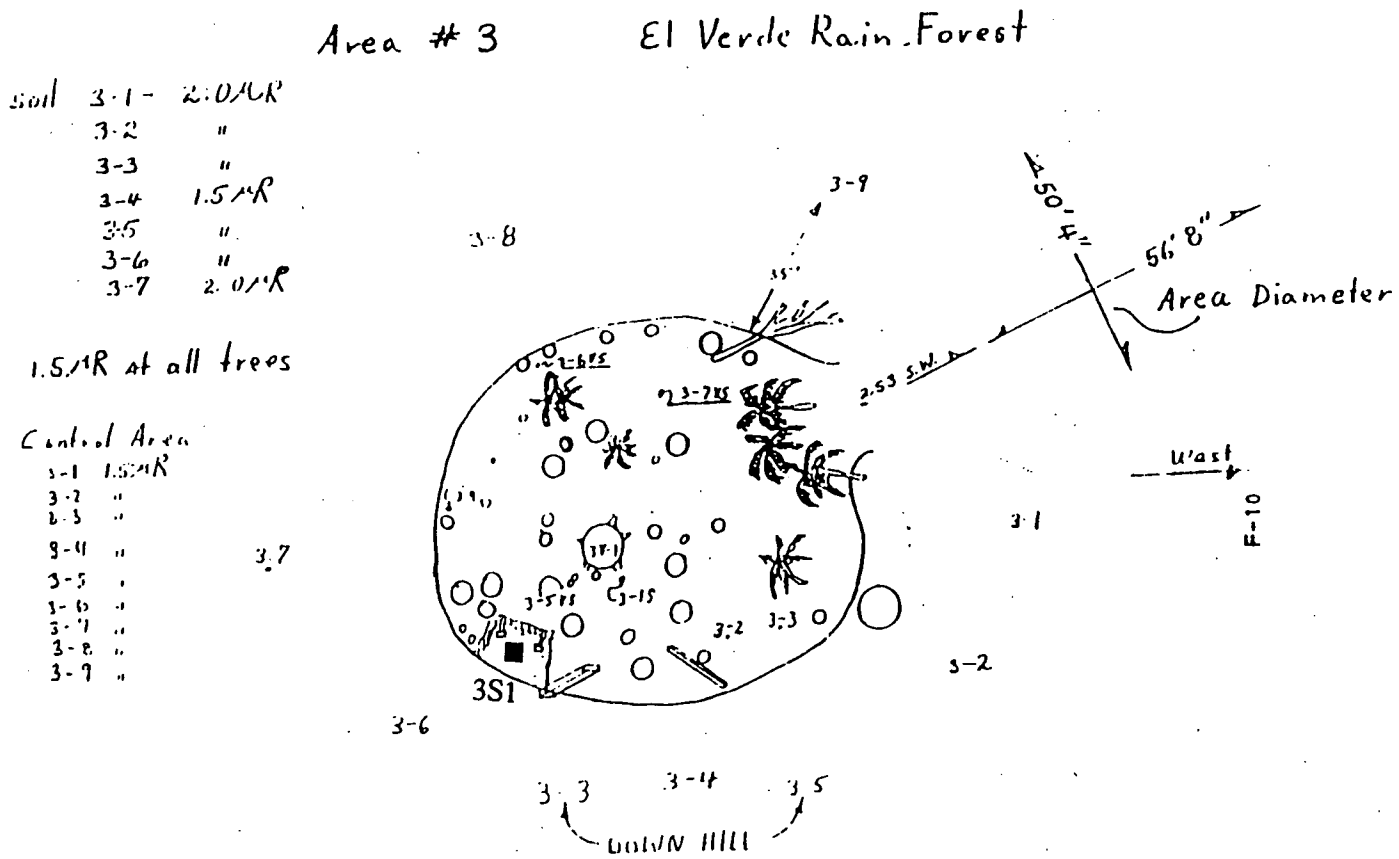

Fig. 6. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 3, EVRS, Puerto Rico (PRE001), and location of ORNL soil sampling (■). ORNL gamma scan range was 2 to 3 μR/h. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER-X-115.[1])

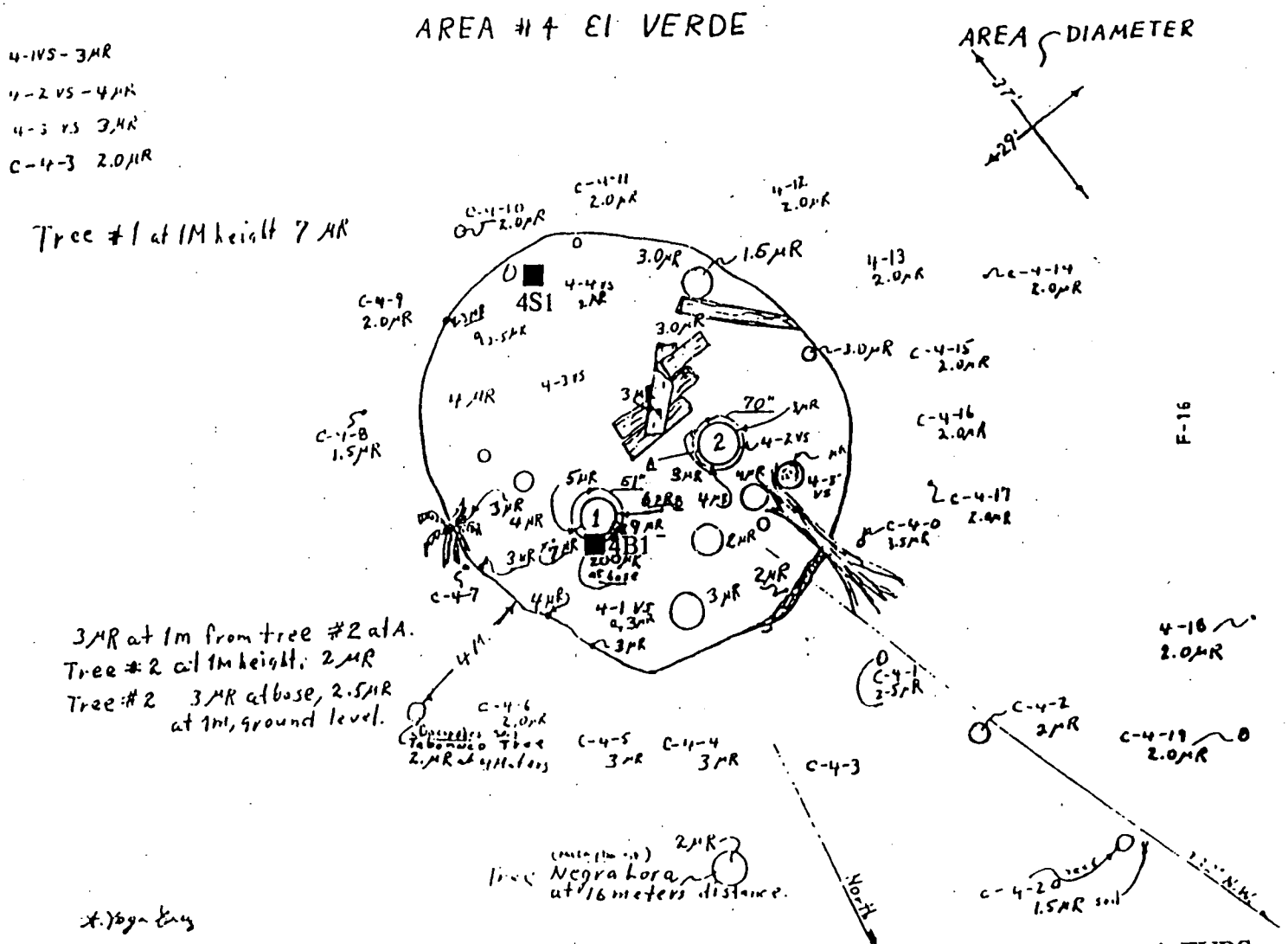

Fig. 7. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 4, EVRS, Puerto Rico (PRE001), and locations of ORNL soil sampling (■). ORNL gamma scan range was 2.5 to 14 μR/h at the perimeter, 5 μR/h at the base of tree #2, 15 μR/h at the base of tree #1, and 170 μR/h under tree #1. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

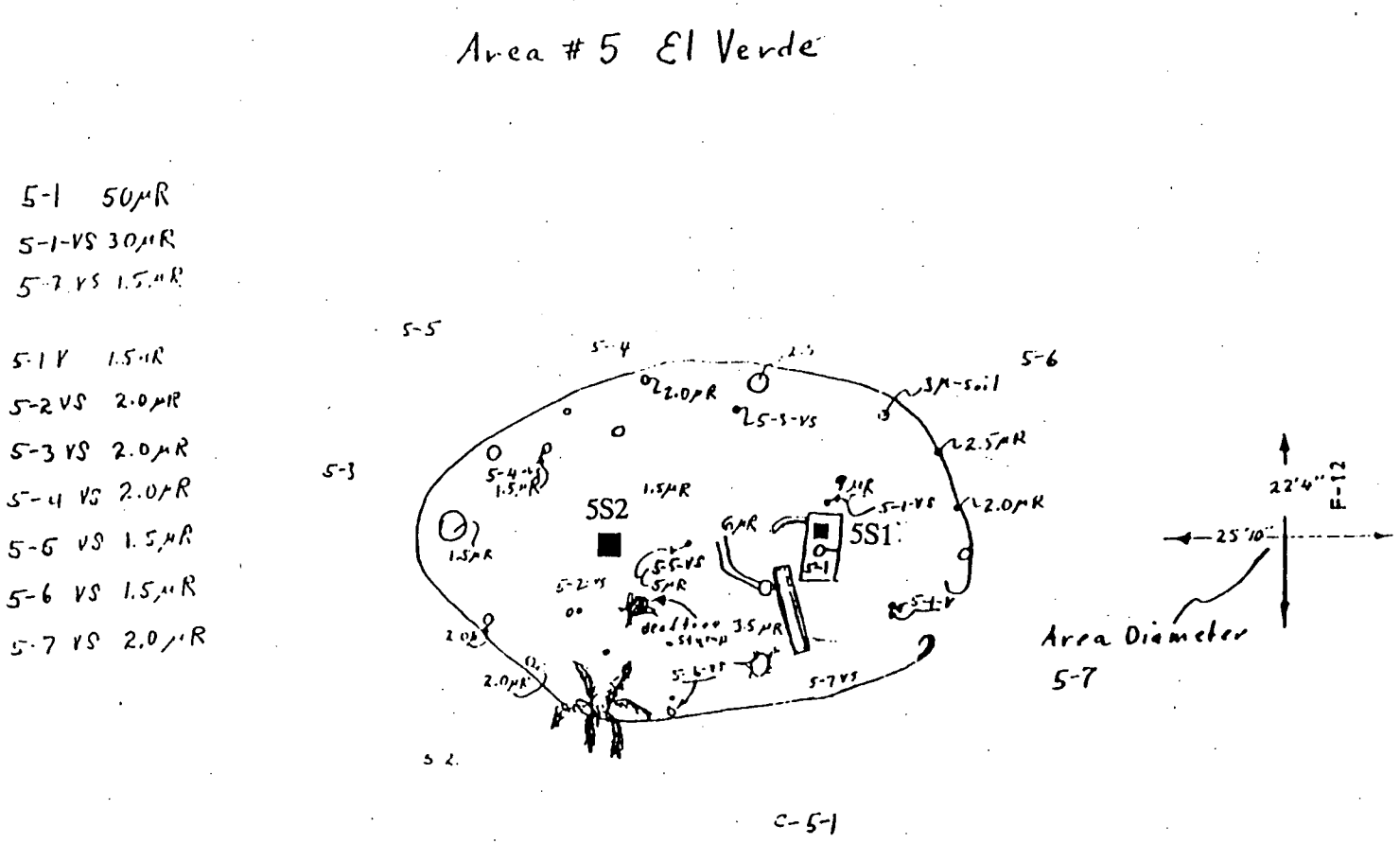

Fig. 8. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 5, EVRS, Puerto Rico (PRE001), and locations of ORNL soil sampling (■). ORNL gamma scan range was 2.5 to 3 μR/h. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

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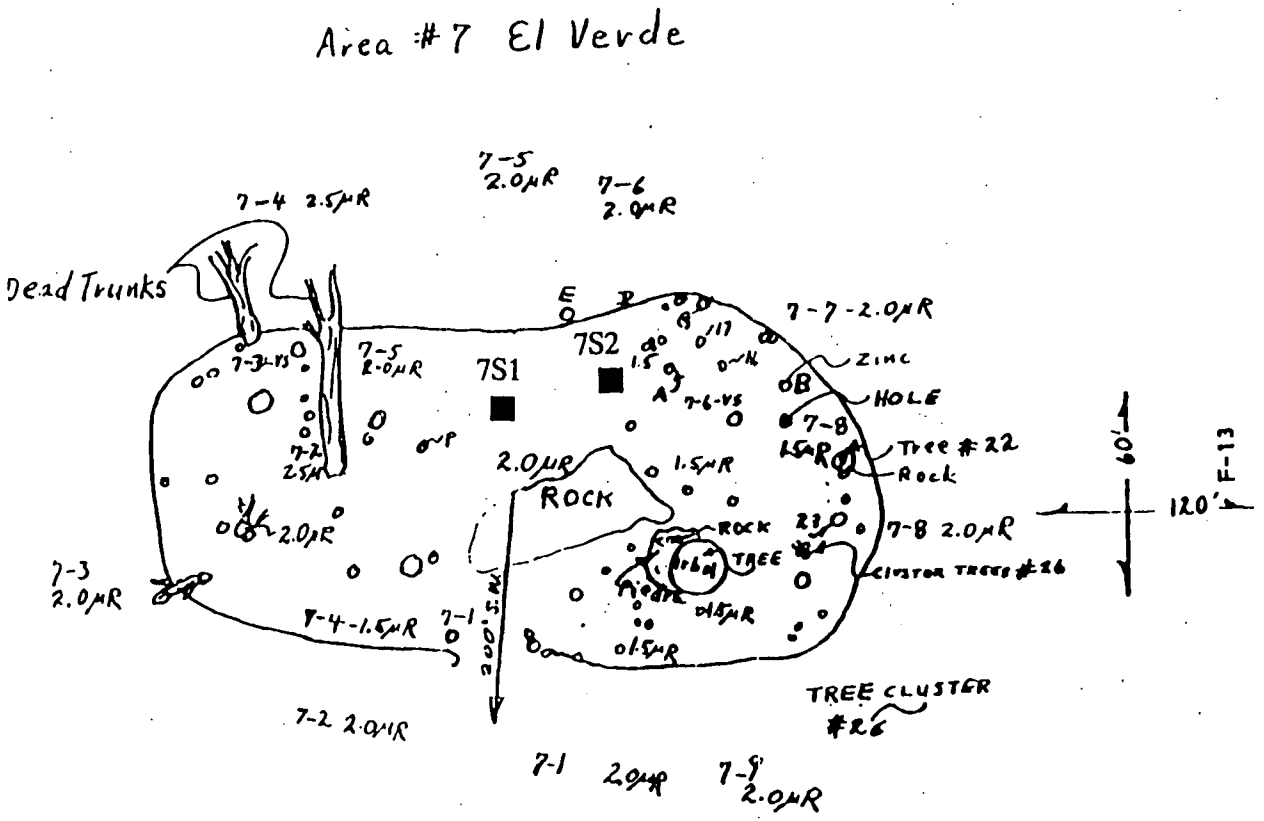

Fig. 9. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 7, EVRS, Puerto Rico (PRE001), and locations of ORNL soil sampling (■). ORNL gamma scan range was 2.5 to 3 μR/h. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER–X–115.[1])

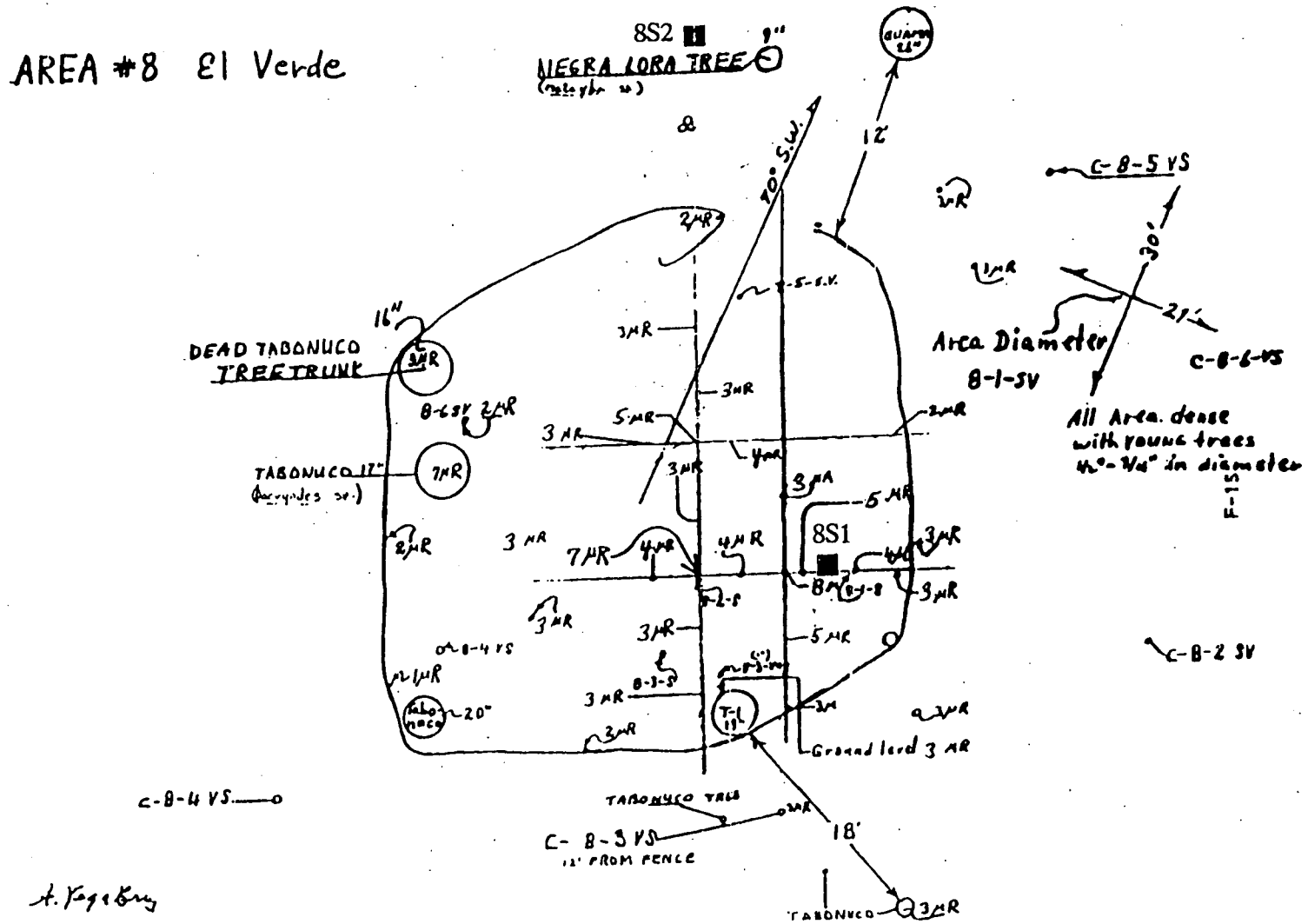

Fig. 10. Diagram of previous EVRS surface gamma radiation levels (μR/h) measured at study area 8, EVRS, Puerto Rico (PRE001), and locations of ORNL soil (■) and vegetation sampling. ORNL gamma scan range was 2 to 3 μR/h. (Figures are duplicated from an earlier report by N. E. Irizarry, CEER-X-115.[1])

ORNL-DWG 89-10893

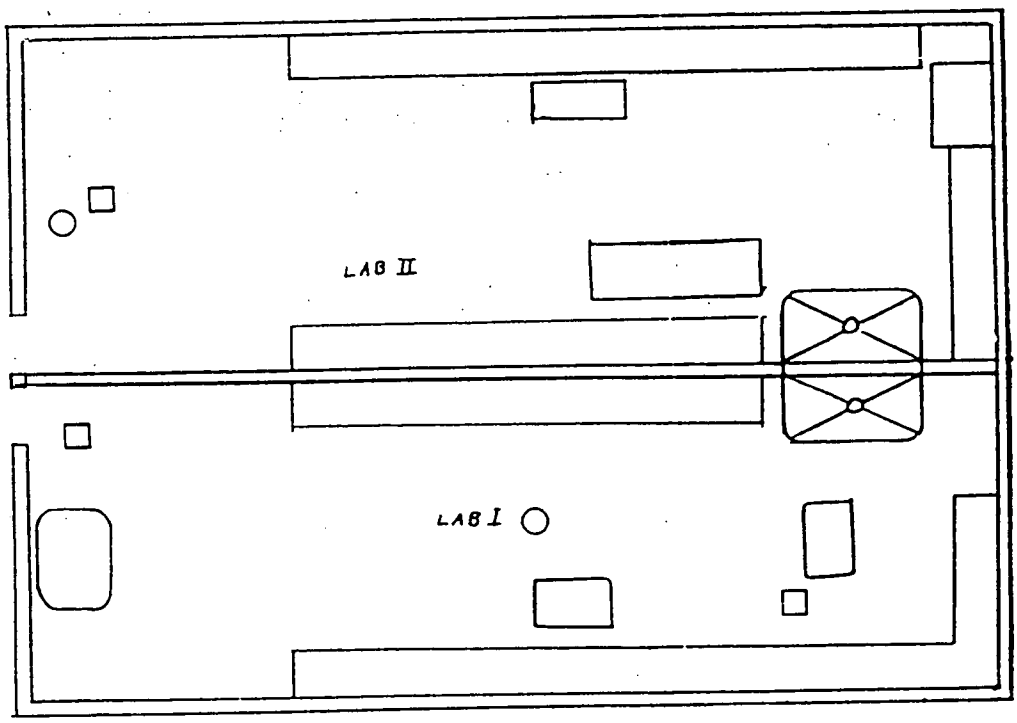

Fig. 11. Plot plan of laboratory building, area A, at EVRS, Puerto Rico (PRE001), showing indoor surface gamma radiation levels and locations of smear samples (□) and direct alpha measurements (○). ORNL gamma scan range was 3 to 5 μR/h.

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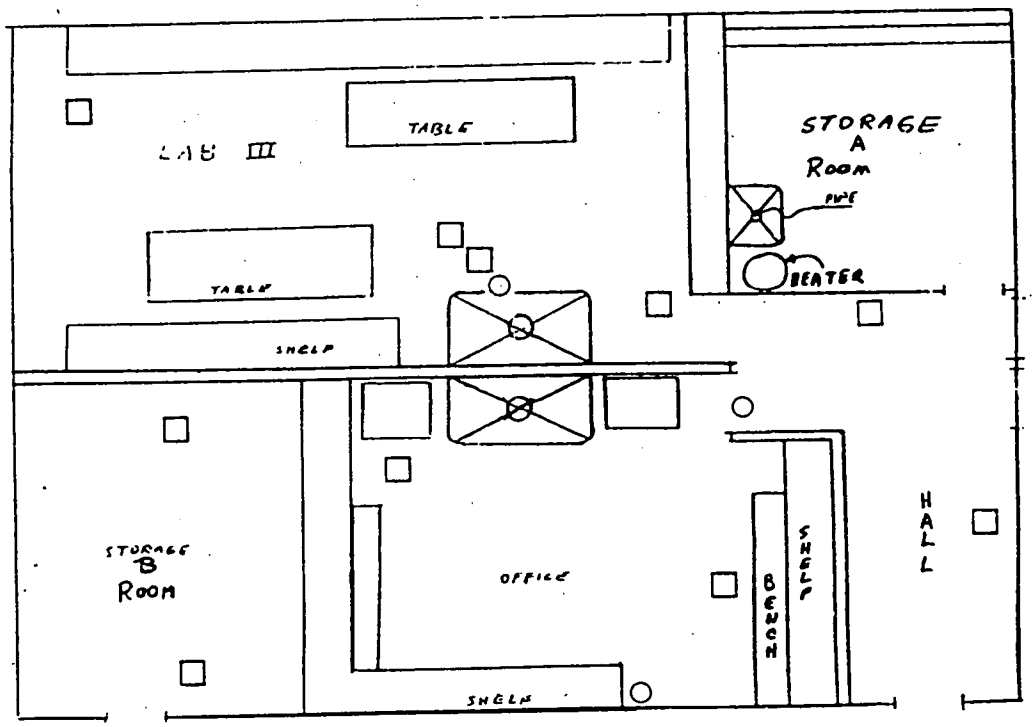

Fig. 12. Plot plan of laboratory building, area B, at EVRS, Puerto Rico (PRE001), showing indoor surface gamma radiation levels and locations of smear samples (□) and direct alpha measurements (○). ORNL gamma scan range was 2.5 to 5 μR/h.

ORNL-DWG 89-10895

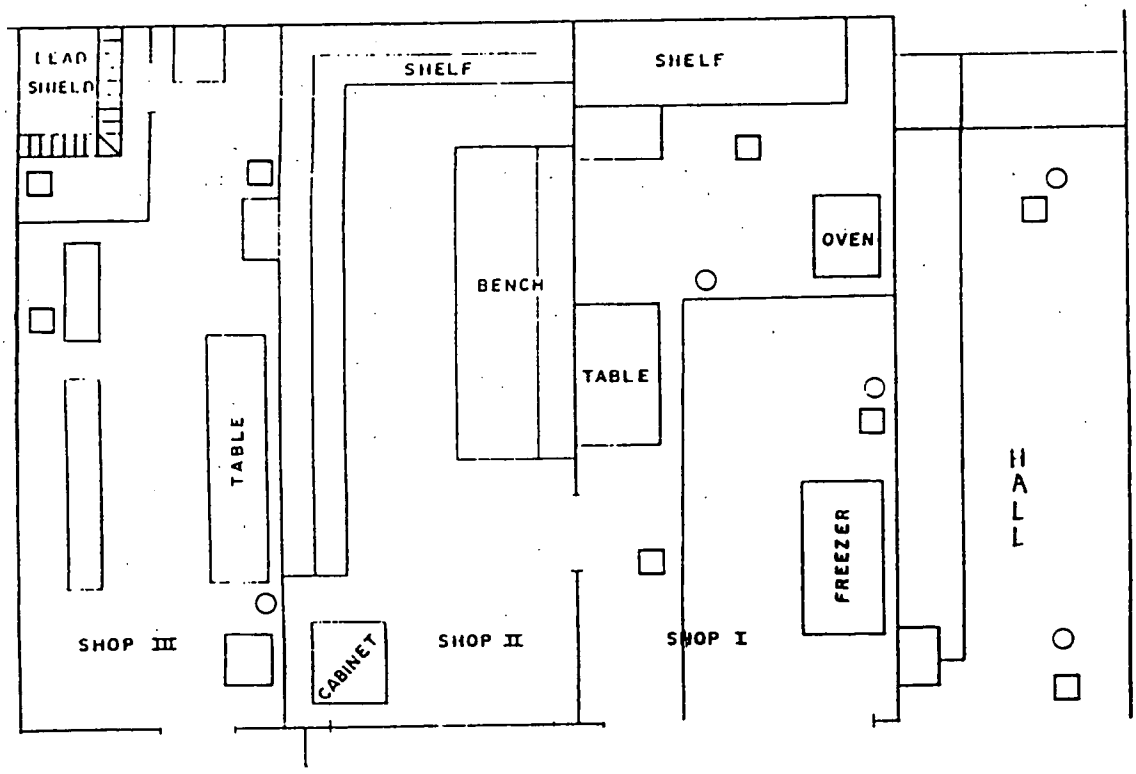

Fig. 13. Plot plan of laboratory building, area C, at EVRS, Puerto Rico (PRE001), showing indoor surface gamma radiation levels and locations of smear samples (□) and direct alpha measurements (○). ORNL gamma scan range was 2.5 to 5 μR/h.

Table 1. Applicable guidelines for protection against radiation[a]

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h
Surface contamination[b]	^{238}U, U-natural(Alpha emitters),& Beta-gamma emitters[c]	
	Fixed on surfaces	5000 dpm/100 cm^2
	Removable	1000 dpm/100 cm^2
	^{232}Th, Th-natural	
	Fixed on surfaces	1000 dpm/100 cm^2
	Removable	200 dpm/100 cm^2
	^{226}Ra	
	Fixed on surfaces	100 dpm/100 cm^2
	Removable	20 dpm/100 cm^2
Beta–gamma dose rates	Surface dose rate averaged over not more than 1 m^2	0.20 mrad/h
	Maximum dose rate in any 100 cm^2	1.0 mrad/h
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m^2 area	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm thick soil layers more than 15 cm below the surface.
	^{232}Th	
	^{230}Th	
	^{228}Ra	
	^{226}Ra	
	^{238}U	Derived (site specific)[d]
	^{137}Cs	Derived (site specific)[e]

[a]Reference 5.

[b]DOE surface contamination guidelines are consistent with the Nuclear Regulatory Commission guidelines found in Reference 6.

[c]Beta–gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{131}I, ^{129}I, ^{126}I, ^{125}I.

[d]DOE guidelines for uranium are derived on a site-specific basis. While none have been derived for this site, guidelines for ^{238}U typically range between 35 and 150 pCi/g.

[e]DOE guidelines for cesium are derived on a site-specific basis. None have been derived for this site.

Table 2. Concentrations of radionuclides in soil and vegetation at El Verde Research Station, CEER, Luquillo, Puerto Rico (PRE001)

Sample[b]	Depth (cm)	Radionuclide concentration (pCi/g)[a]		
		^{137}Cs	^{232}Th	^{238}U
		Systematic samples[c]		
2S1	0–15	1.47±0.04	0.34±0.04	0.80±0.62
2S2	0–15	0.29±0.02	0.31±0.03	0.92±0.78
3S1	0–15	1.58±0.03	0.22±0.03	0.85±0.58
4S1	5–13	2.53±0.03	0.32±0.03	0.69±0.44
5S1	0–15	1.02±0.02	0.33±0.02	1.02±0.57
5S2	0–15	1.39±0.03	0.35±0.03	1.60±0.74
7S1	0–10	0.89±0.02	0.24±0.02	0.99±0.61
7S2	0–15	1.75±0.04	0.29±0.03	1.13±0.76
8S1	0–13	0.82±0.02	0.31±0.02	1.34±0.41
8S2	0–15	1.23±0.03	0.27±0.02	0.67±0.28
		Biased sample[d]		
4B1	0–15	370 ±2.42	0.29±0.26	2.96±3.49
		Vegetation sample[e]		
8V1	N/A	1.10±0.14	0.56±0.21	8.41±2.51

[a]Indicated counting error is at the 95% confidence level (±2σ).

[b]Locations of soil samples are shown on Fig. ?.

[c]Systematic samples are taken at locations irrespective of gamma exposure rates.

[d]Biased samples are taken from areas with elevated gamma exposure rates.

[e]Vegetation sample was taken from a variety of plants in area 8.

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CEER-X-115

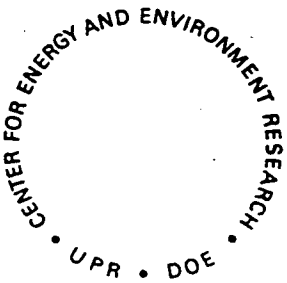
RADIOLOGICAL SURVEY REPORT

for

EL VERDE RESEARCH STATION

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

HEALTH AND SAFETY DIVISION



CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO — U.S. DEPARTMENT OF ENERGY
November, 1981
Revised May, 1983

RADIOLOGICAL SURVEY REPORT

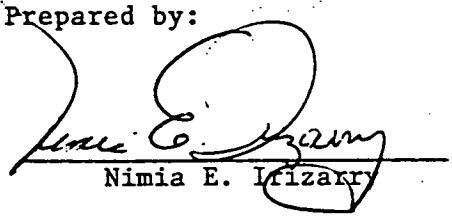
for

EL VERDE RESEARCH STATION

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

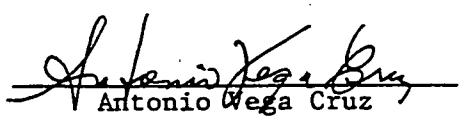
HEALTH AND SAFETY DIVISION

Prepared by:



Nimia E. Irizarry

November, 1981
Date



Antonio Vega Cruz

Revised: May, 1983

CERTIFICATION

It is hereby certified that the areas described in this report do not represent a radiation hazard to the public nor to any person working in El Verde Research Station. From a radiation standpoint these facilities could be safely used under the conditions stated in NRC License Number 52-1934-02 of March 9, 1982 as amended on October 13, 1982. (Appendix IV)

May 1983
Date

Nimia E. Irizarry
Head, Health and Safety Division

TABLE OF CONTENTS

LIST OF FIGURES

FIGURES

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_____
Date

_____
Nimia E. Irizarry
Head, Health and Safety Division

ABSTRACT

The Radiological Survey and the Decontamination, as indicated below, of El Verde Research Station has been completed.

Areas 8, 5 and 4 were found contaminated. All contamination was removed from areas 8 and 5. Figures 12, 14 and 15.

The contamination in area 4 (Figure 16) was identified as Cs-137 and was removed down to a radiation level of 200 uR/hr. Even though this radiation level does not constitutes a hazard for the public or personnel working in the area, access to it has been controlled by a fence and appropriate warning signs. On December 1981 an NRC License was requested for the use of Cs-137 and Tritium in the forest. The Nuclear Regulatory Commission granted to CEER-UPR license No. 52-1934-02 on March 1982.

The contaminated soil that was removed from areas 3, 5 and 4 was packed in DOT approved containers and was shipped to a low level waste disposal site in Oak Ridge, Tennessee on September 1982.

INTRODUCTION

The Puerto Rico Nuclear Center was developed during the early 1960's under the sponsorship of the Atomic Energy Commission with the main goal of developing a comprehensive program for research and training in nuclear science and engineering and in the applications of nuclear energy in medicine, agriculture and industry.

As part of the projects developed in order to achieve this goal, the Terrestrial Ecology Division was started in 1963. In 1964 a memorandum of agreement was signed between the Atomic Energy Commision and the Forest Service, US Department of Agriculture, separating 156 acres in the Luquillo Experimental Forest, i.e., El Verde Rain Forest, for conducting detailed ecological studies. Figures 1 and 1-A.

The main study area is located on the "northwestern slope of the mountain" and the research station is built on the site of a former coffee plantation. Several study areas were developed just up the mountain and to the east across the Sonadora River. (9). Access to the area is controlled by means of a hog wire fence, 8 ft high. The presence of patrol dogs also aids in the security of the area.

From 1964 on, a large amount of research projects were made in El Verde. Vegetation was quantified and identified, pollen was analized, a detailed study of the climate was made, soil was studied and many other aspects of the Rain Forest were thoroughly studied. (11)

Radiotracers were used, beside other techniques, during the study of mineral cycling and forest metabolism.

In 1976 the goals and objectives of PRNC changed, PRNC became the Center for Energy and Environment Research and the AEC-ORO (then ERDA and now the Department of Energy) concurred on transferring CEER

facilities to the University of Puerto Rico and terminating the agreement with the Forest Service. CEER/UPR will continue to use this research area under a use permit from the Forest Service.

In the process, a radiological survey was planned and has been done during the last three years. The area under CEER's responsibility was thoroughly surveyed using portable survey meters. Instrumentation used for this survey is listed on page 12. During this walk-through survey, some soil plots were found fenced and marked with radiation safety signs. These areas or plots were surveyed in more detail and samples were taken and analyzed for gross beta, gamma and alpha contamination. Also spectrometric analysis was done to representative samples of each of this areas. Except for three of these plots, no other areas were found with contamination or radiation levels higher than background.

This Report summarizes the activities carried out during the radiological survey and documents the results.

HISTORICAL BACKGROUND

The Terrestrial Ecology Program was initiated on April 1963. A month later, the work at El Verde Rain Forest started with three major objectives as follows:

1. To determine the effects of gamma irradiation from a 10,000 Ci Cesium-137, sealed source, on a plot of lower montane rain forest.
2. To measure the cycles of fallout elements in the rain forest system.
3. To determine the circuits of energy flow and metabolic processes of the ecosystem in order to understand the phenomena observed. (8).

During the first year of work at El Verde, all efforts were directed towards the study of the general conditions before gamma irradiation.

There is no record of mayor tracer studies during 1963 except in August when three trees were tagged by injecting 1 mCi of ^{32}P-phosphoric acid into each of the tree stems. (9)

On September 16, 1964 an agreement was reached and a memorandum of understanding between the Atomic Energy Commission and the Forest Service, United States Department of Agriculture was signed in order to separate 156 acres of the El Verde Rain Forest for conducting detailed ecological studies of the effects of gamma radiation, (Cs-137), upon tropical forests.

Figures 1 and 1-A show the location and detail of the area included in the Agreement.

A preliminary irradiation with a 6 Ci Co-60, sealed source, was carried out on August 1964 to help predict the attenuation of gamma radiation in the forest and to verify the hazards report for the ^{137}Cs sealed source.

The 10,000 Ci cesium-137, sealed source, was installed on top of a small ridge in the Rain Forest on December 7, 1964. The area was exposed to gamma radiation for the period between January 19, 1965 to April 27, 1965. It was removed and shipped to USA during July 1966. This source had no record of leakage and therefore did not constitute a potential source of contamination to any area in the forest. (10).

It must be mentioned, though, that during the arrangements made for this irradiation project, El Verde site was fenced at radii of 80 m, 160 m and 500 m from the radiation center. These fences have been used as reference points during the radiological survey being reported at present. See Figure 2.

When the irradiation was completed and the immediate post-irradiation effects were under study, plans were developed for studying mineral cycling, cycles of fallout elements and metabolic processes. Among other methods, radioactive tracers were used in numerous experiments during this period of time.

In January 1966 tracer experiments involving the use of Strontium-85, Cesium-134 and Manganese-54 were initiated. These experiments were carried out throughout the whole year and ended in December 1966. "The objective of the experiment was to determine whether these nuclides could be transferred from litter to soil to roots of understory plants, and, if so, at what rates.

Four plots were established within a fenced enclosure on a gently sloping ridge top within El Verde contract area. These plots, which ranged from 1 to 1.5 m^2, were completely encircled with corrugated aluminum garden edging to a depth of 3 inches, and roots to this depth were cut to prevent export of nuclides to trees outside of the plots. Two of the plots were stripped of all litter and two were left intact prior to the application of nuclides. On January 6, 1966, approximately 1 mCi/m^2 of each, ^{134}Cs, ^{85}Sr and ^{54}Mn were applied to the plots, in the form of a spray from a hand-pumped garden sprayer. All plants within the plots, at this time, were covered with plastic bags and aluminum foiled to prevent contamination with spray." (3)(4)(10)

Purchase order records indicate that on May 1966, the Terrestrial Ecology Project bought 1 Curie of Tritium to be used in future experiments within the Rain Forest.

During February 1967, twenty microcuries of Tritium were diluted to 1 liter of water and the mixture was applied to the surface of a 0.94 m^2 soil plot. (5).

Later, on August 3, 1967, three tree's trunks were tagged by spraying each with 1 mCi of carrier free ^{65}Zn solution. This study was designed to evaluate the utilization by the snail Caracolus caracola, of lower plants growing on the tree trunks. (5)

On August 10, 1967, 1 mCi of ^{85}Sr and 0.8 mCi of ^{134}Cs were diluted in 2,500 ml of water and evenly applied to a small plot of soil. (5)

Tritium was repeatedly used during 1968 and 1969. Five more experiments using this radiotracer were planned and carried out.

One of the experiments consisted on injecting three trees with different amount of ^{3}H as follows:

1. Large Dacryodes excelsa ..... 20 mCi
2. Sloanea berteriana ..... 6 mCi
3. Small Dacryodes excelsa ..... 1 mCi

Another experiment, done during May 1968, consisted on evenly applying four liters of water containing 50 mCi on Tritium to a 3.7 m^2 soil plot.

Two more experiments involving the use of Tritium were reported in June 1969, but there is no record of the amounts of the isotope used. (1)

Experiments using Cesium-137, Strontium-85 and Manganese-54 continued. In September 18, 1968 a tree of the species Matayba dominguensis was injected with 0.46 mCi of ^{137}Cs and a Dacryodes excelsa was injected with 0.19 mCi of ^{85}Sr, 0.34 mCi of ^{54}Mn and 17.69 mCi of ^{86}Rb. (1).

Also during 1968 another experiment using tritiated water was reported but the amounts of the radioisotope are not mentioned.

The next reference to the use of radioisotopes was reported in June 1970. In this report, ^{32}P. ^{75}Se, ^{65}Zn and ^{59}Fe are mentioned as the radioisotopes used to study nutrient pathways and depth of nutrient uptake. This experiment apparently was carried out in plastic trays in the laboratory. (11).

Another reference to the tagging of trees using ^{32}P does not specify the date of the experiment but it is mentioned that 1 mCi of the isotope was used for injecting two trees of species Sloanea berteriana and Dacryodes excelsa. Reference to this study is made in "A Tropical

Rain Forest". (10) Since this book was published in 1970, it is assumed that this ^{32}P experiment was performed in 1969 or before.

After 1970, the Terrestrial Ecology Division reported only one event involving the use of radioisotopes, i.e., the tagging of a Giant Tree Fern, Cyathea arborea. The tree was tagged during June 1973 with unknown amounts of ^{32}P.

Based on these data, Table 1 has been prepared. It is a summary of the radioisotopes used, amounts used and date and location of the experiment.

ISOTOPE (S)	DATE AND AREA APPLIED	ORIGINAL ACTIVITY	HALF LIVES PASSED
^{3}H	Jan. 6 1967; Area 2 (Fig.9)	20mCi	1.30
^{3}H;	May 1968 Area 3 (Fig.10)	50 mCi	1.22
^{32}P	1969 "	1 mCi	357.07
^{32}P	1972 "	46 mCi	280.57
^{137}Cs	Sept.18,1968 Area 4 (Fig.11)	0.46 mCi	0.5
^{86}Rb	" " "	17.69 mCi	293.41
^{85}Sr	" " "	0.19 mCi	84.62
^{54}Mn	" " "	0.34 mCi	17.49
^{85}Sr	Aug.10, 1967 Area 5 (Fig.12)	1 mCi	90.26
^{134}Cs	" " "	0.8 mCi	7.77
^{65}Zn	Aug. 3, 1967 Area 7 (Fig.13)	3 mCi	16.99
^{134}Cs	Jan. 6, 1966 Area 8 (Fig.14)	1 mCi	8.25
^{85}Sr	" "	1 mCi	95.90
^{54}Mn	" "	1 mC	19.92

Table 1 - Summary of radioisotope usage in El Verde Rain Forest

It must be mentioned that, associated with the field activities, there is a laboratory building that was constructed in 1965.

Another laboratory, adjacent to the first one, was constructed in 1976. There is no record of radioisotope usage in the new laboratory.

On the other hand, it is assumed that some sample preparation involving the use of radiotracers was performed in the old laboratory. Figure 3 shows the laboratory area.

SUMMARY OF THE RADIOLOGICAL SURVEY

A Radiological Survey was planned and performed in order to determine the status of El Verde facilities and research areas from radioactive contamination standpoint. The survey included a survey of the radiation levels and removable contamination in the old laboratory building and a walk-through survey of the forest. Also, soil and vegetation samples were collected and analyzed.

1. Survey in the Laboratory Building:

The radiation levels within the laboratory were measured using portable Geiger Muller and Scintillation survey meters. The benches, tables, drawers, instruments, floors, walls, materials and other surfaces were scanned on contact and at 1 meter high.

Since the laboratory building is included in NRC License No. 52-1934-02, and at the time of the survey there were plans for the use of radioisotopes such as Tritium, no efforts were made to survey the drains, hoods exhaust system, sink traps, etc.

The survey for removable contamination was done using the standard smear technique. Figures 4, 5 and 6 show the areas where the smears were taken.

2. Survey of the Forest

A walk-through survey was done in the forest, starting from the laboratory area through the trails up to the radiation center where the Cs-137 source was installed on 1964. The survey was extended to three, six and twelve meters from the trails. The area within the 160 m radius was surveyed in a grid of approximately one meter.

This part of the survey was performed at ground level, and 1 meter high, using earphones in order to more precisely detect variation in radiation levels in spite of the inequality of the ground.

During the walk-through survey, six areas were found fenced with chicken wire screens and marked with radiation safety signs. These areas were marked as follows: areas 2, 3, 4, 5, 7 and 8, based on numbers already existing within the fenced plots. For the purpose of this report, these areas will be called hereinafter, area ____ as numbered. Figure 7 shows the approximate location of these areas. Each area was thoroughly surveyed, and a detailed map of the radiation levels was done. Also, soil and vegetation samples were collected in the areas.

In order to have a complete idea of the status of the surrounding grounds, soil samples were also collected outside of the fenced areas, beyond the radiation safety signs. All soil samples were collected from surface 6 inches and from next 6 inches deep in the ground.

Soil and vegetation samples, representative of each area were analyzed for radionuclide content in a Germanium Lithium drifted detector. Also, other portions were oven dried, grinded and an alliquot of 200 mg was counted in a Gas Flow Proportional Counter, for gross

alpha and beta-gamma contamination. Microcuries per gram were calculated using the following formula;

$$uCi/g = \frac{\text{net cpm}}{A\ (F)\ 2.22 \times 10^6}$$

where A= amount of sample analyzed (g)

F= efficiency factor = 50%

RESULTS OF THE RADIOLOGICAL SURVEY BEFORE DECONTAMINATION

The initial Radiological Survey for El Verde Research Areas was carried out during different intervals of time in FY 1978 through FY 1981.

The background radiation level varies from 2 uR/hr to 6 uR/hr in the laboratory area and in the forest. Figure 8 shows the detailed radiation levels in the laboratory area.

Each one of the areas was surveyed in detail. Figures 9, 10, 11, 12, 13, and 14 show the radiation levels and location of the samples taken inside and beyond the fence of each area. Samples taken beyond the fence are identified as control samples.

Based on the description and clues found in each area, spectrometric analysis of some samples and the descriptions found in the literature searched, the isotopes used in each sampling zone were identified as follows:

Area 2	- ^{3}H
Area 3	- ^{3}H, ^{32}P
Area 4	- ^{137}Cs, ^{85}Sr, ^{54}Mn, ^{86}Rb
Area 5	- ^{85}Sr, ^{134}Cs
Area 7	- ^{65}Zn
Area 8	- ^{134}Cs, ^{85}Sr, ^{54}Mn

Appendix 1 is a summary of the results of the samples analyzed for gross beta-gamma and gross alpha contamination.

Appendix 2 is a summary of the samples analyzed in the GeLi spectrometer.

Three of the areas were found with radiation levels higher than background: Areas 4, 5 and 8. See Figures 11, 12 and 14.

No contamination was found in the laboratory building.

Appendix 1A shows the results of all the smears taken in this building. No samples were taken in the new laboratory constructed in 1976.

Soil samples from an area where no radioisotopes have been used, were taken and analyzed in order to establish a background level for comparison purpose. The results of these soil samples are included in Appendix 3.

INSTRUMENTS USED

1. Ludlum Measurements, Inc.
   Model 3, Pancake GM 1.5 mg/cc window
   Sweetwater, Texas

2. Scintillation Gamma Ratemeter Type 1597A
   Reactor Control Division
   Eliot Process Automation Limited
   Lewisham, London, S.E. 13

3. Nuclear Measurements Corporation
   Gas Flow Proportional Counter
   Model PCC-IIT-DS-IT Combination
   50% Eff. Ave. efficiency for gamma energies from 0.500 Mev to 1.3 Mev.
   NMC Indianapolis, Indiana

4. Nuclear Data 4410 Spectrometer
   with a GeLi Detector
   Nuclear Data Inc.

5. Liquid Scintillation Counter
   Beckman Model LS 3133T
   Beckman Inc., California
   30% Eff. for Tritium

DECONTAMINATION, PRESENT STATUS AND CONCLUSIONS

Decontamination efforts were concentrated to two of the areas: 4 and 8. The contaminated soil in area 5 was readily removed.

The contaminated soil was removed until an aluminum tray was found about 30 cm deep in area 8. Beyond this level no contamination was found. About 1,000 lb (453 kg) of soil were removed, placed in plastic bags and transported to CEER Mayaguez for proper disposal.

At the present time the radiation levels in area 8 vary from 2 uR/hr to 10 uR/hr. See figure 15 for a diagram of the radiation levels.

Two trees were found contaminated in area 4. The resin of the tree, as well as some pieces of cortex, were analyzed in the spectrometer and ^{137}Cs was found as the contaminant. No attempt was made to quantify the remaining isotope. Soil contaminated with cesium underneath the tree, was removed. Even though about 100 lb (43 kg) of soil were removed, the radiation level under the tree is still higher than background, i.e. about 200 uR/hr. Figure 16 shows the present status of this area.

The contaminated tree remains in place and the Forest service concurred with CEER that El Verde Research area should be licensed for the use of radiotracers. A license application was submitted to the Nuclear Regulatory Commission and License No. 52-1934-02 was granted on March 9, 1982.

Area 4 will remain fenced and with radiation safety signs. All other radiation safety signs have been removed.

Of the radioisotopes used in El Verde, (Table 1), tritium is the one of more concern because it could be incorporated into the human body following ingestion of HTO, by passing through skin or inhalation either

as liquid or in a gaseous form. However, this concern is lessened in view of the relatively short biological half-lifes **which are involved. For example, NCRP Report No. 62 indicates that: "It seems reasonable to conclude that one pool of tritium in exposed individuals is in the form of free body water. It has a (biological) half-life between 6 and 18 days." (6)

We conclude on the basis of the observations (Jordan 1970) that any tritium used in the area has been dissipated in the atmosphere as water vapor.

Jordan estimated the half residence time ($t_{\frac{1}{2}}$)* for tritium in the soil, in the vegetation and in the air in a tropical ecosystem such as El Verde. (2)

According to Jordan, tritium moves into the air through evaporation of the water in the litter, in such a way that, the half-residence time of the ^{3}H in the soil and litter, necessarily controls concentration in the water vapor above the spiked soil. The results in his experiments indicated that: "29 days probably is a good estimate for the $t_{\frac{1}{2}}$ of tritium in the soil as a whole." (2)

He found that for trees growing in soil spiked with tritium, the $t_{\frac{1}{2}}$ is between 41 and 55 days. For those trees (Dacryodes excelsa) where the isotope was injected, the $t_{\frac{1}{2}}$ of tritium was 6.6 days (2)

If one Curie (1 Ci) of tritium bought on 1966 was used during 1969 and experienced a half-residence time of 55 days, the amount remaining in 1983 would be 1.95×10^{-27} Ci.

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* Half residence time = is the length of time that it takes for half the activity in a compartment to be removed.

** Biological half-life = is the time required for the body to eliminate by regular process of elimination one half of a dose received of any substance

Based on the above observations, then we conclude, that biological cycling and the movement of tritium in a tropical ecosystem as El Verde is such that all tritium used in the research area has been dispersed to the atmosphere in very low levels not dangerous to either the public or to persons working in the area.

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APPENDIX 1.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date May - June - Nov. '78

Technician Ramón Pérez

Sampling zone Area #2

Instrument used PCC - 11T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-2-1A	1.35×10^{-5}	0 **	2-3A	9.0×10^{-6}	0
C-2-1B	4.05×10^{-5}	0	2-3B	4.5×10^{-6}	0
C-2-2A	2.25×10^{-5}	0	2-Lys A	4.5×10^{-5}	0
C-2-2B	4.05×10^{-6}	0	2-Lys B	$< 4.5 \times 10^{-6}$	0
C-2-3A	$< 4.5 \times 10^{-6}$	0	2-1A	$< 4.5 \times 10^{-6}$	0
C-2-3B	4.5×10^{-6}	0	2-1B	$< 4.5 \times 10^{-6}$	
C-2-4A	1.35×10^{-5}	0			
C-2-4B	$< 4.5 \times 10^{-6}$	0			
C-2-5A	4.05×10^{-5}	0			
C-2-5B	2.25×10^{-5}	0			
C-2-6A	4.50×10^{-6}	0			
C-2-6B	$< 4.50 \times 10^{-6}$	0			
C-2-7A	$< 4.5 \times 10^{-6}$	0			
C-2-7B	$< 4.50 \times 10^{-6}$	0			
C-2-8A	7.21×10^{-5}	0			
C-2-8B	4.05×10^{-5}	0			
C-2-9A	9.00×10^{-6}	0			
C-2-9B	$< 4.50 \times 10^{-6}$	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date April '78

Technician Ramón Pérez

Sampling zone Area #3

Instrument used DS-1T
Background β γ 60 dpm I 10
Background α 0 dpm
Sample Vol. or Wt. 200mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
3-C-A	$<4.50 \times 10^{-6}$	0**			
3-C-B	"	0			
3-C-C	"	0			
3-1A	"	0			
3-1B	"	0			
3-1C	"	0			
3-2A	"	0			
3-2B	"	0			
3-2C	2.70×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5}µ Ci

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Jun - Jul '78

Technician Ramón Pérez

Sampling zone Area #3

Instrument used DS-1T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-3-1A	3.15×10^{-5}	0**	3-1A	7.21×10^{-5}	0
C-3-1B	1.35×10^{-5}	0	3-1B	3.15×10^{-5}	0
C-3-2A	9.0×10^{-6}	0	3-2A	2.70×10^{-5}	0
C-3-2B	4.5×10^{-6}	0	3-2B	3.60×10^{-5}	0
C-3-3A	2.25×10^{-5}	0	3-3A	9.00×10^{-6}	0
C-3-3B	9.0×10^{-6}	0	3-3B	9.00×10^{-6}	0
C-3-4A	1.35×10^{-5}	0	3-4A	2.7×10^{-5}	0
C-3-4B	1.80×10^{-5}	0	3-4B	9.0×10^{-6}	0
C-3-5A	1.35×10^{-5}	0	3-5A	$< 4.50 \times 10^{-6}$	0
C-3-5B	1.80×10^{-5}	0	3-5B	$< 4.50 \times 10^{-6}$	0
C-3-6A	4.50×10^{-6}	0	3-5A Lys S.	1.80×10^{-5}	0
C-3-6B	9.0×10^{-6}	0	3-5B Lys S.	3.15×10^{-5}	0
C-3-7A	9.0×10^{-6}	0	3-6A	2.25×10^{-5}	0
C-3-7B	4.50×10^{-6}	0	3-6B	1.35×10^{-5}	0
C-3-8A	4.05×10^{-5}	0	3-7A	2.70×10^{-5}	0
C-3-8B	1.35×10^{-5}	0	3-7B	4.95×10^{-5}	0
C-3-9A	2.70×10^{-5}	0			
C-3-9B	1.35×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Nov. '78

Technician Ramón Pérez

Sampling zone Area # 4

Instrument used Rec-11T, DS-1T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
4-1A	2.70×10^{-5}	0**			
4-1B	4.50×10^{-6}	0			
4-2A	1.80×10^{-5}	0			
4-2B	2.25×10^{-5}	0			
4-3A	1.35×10^{-5}	0			
4-3B	$< 4.50 \times 10^{-6}$	0			
4-4A	4.95×10^{-5}	0			
4-4B	1.35×10^{-5}	0			
4-5A	2.25×10^{-5}	0			
4-5B	1.80×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Nov. '78

Technician Ramón Pérez

Sampling zone Area #4

Instrument used DS-1T
Background β γ 60 dpm ±10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-4-0A	$<4.50\times10^{-6}$	0**	C-4-12A	1.35×10^{-5}	0
C-4-0B	"	0	C-4-12B	4.50×10^{-6}	0
C-4-1A	"	0	C-4-13A	4.50×10^{-6}	0
C-4-1B	4.50×10^{-6}	0	C-4-13B	$<4.50\times10^{-6}$	0
C-4-2A	$<4.5\times10^{-6}$	0	C-4-14A	9.0×10^{-6}	0
C-4-2B	4.50×10^{-6}	0	C-4-14B	$<4.5\times10^{-6}$	0
C-4-3A	4.5×10^{-6}	0	C-4-15A	"	0
C-4-3B	9.00×10^{-6}	0	C-4-15B	"	0
C-4-4A	1.35×10^{-5}	0	C-4-16A	4.05×10^{-5}	0
C-4-4B	9.00×10^{-6}	0	C-4-16B	$<4.5\times10^{-6}$	0
C-4-5A	1.35×10^{-5}	0	C-4-17A	"	0
C-4-5B	1.80×10^{-5}	0	C-4-17B	9.00×10^{-6}	0
C-4-6A	$<4.50\times10^{-6}$	0	C-4-18A	3.6×10^{-5}	0
C-4-6B	1.35×10^{-5}	0	C-4-18B	4.50×10^{-6}	0
C-4-10A	1.80×10^{-5}	0	C-4-19A	$<4.50\times10^{-6}$	0
C-4-10B	1.35×10^{-5}	0	C-4-19B	4.50×10^{-5}	0
C-4-11A	1.80×10^{-5}	0	C-4-20A	$<4.50\times10^{-6}$	0
C-4-11B	$<4.50\times10^{-6}$	0	C-4-20B	"	0

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5}µ Ci

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Sept. 1978

Technician Ramón Pérez

Sampling zone Area #5

Instrument used PCC-11T
Background β γ 60 dpm ±10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil & Veg.

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-5-1A	1.80×10^{-5}	0 **	5-3A	4.50×10^{-5}	0
C-5-1B	3.15×10^{-5}	0	5-3B	2.70×10^{-5}	0
C-5-2A	1.35×10^{-5}	0	5-4A	4.05×10^{-5}	0
C-5-2B	4.95×10^{-5}	0	5-4B	"	0
C-5-3A	9.00×10^{-6}	0	Veg. A	9.00×10^{-6}	0
C-5-3B	4.05×10^{-5}	0	Veg. B	4.50×10^{-6}	0
C-5-4A	4.50×10^{-5}	0			
C-5-4B	2.25×10^{-5}	0			
C-5-5A	4.50×10^{-5}	0			
C-5-5B	2.25×10^{-5}	0			
C-5-6A	2.25×10^{-5}	0			
C-5-6B	3.15×10^{-5}	0			
C-5-7A	4.95×10^{-5}	0			
C-5-7B	6.30×10^{-5}	0			
5-1A	4.05×10^{-5}	0			
5-1B	3.15×10^{-5}	0			
5-2A	2.25×10^{-5}	0			
5-2B	3.60×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Sept. '78

Technician Ramon Perez

Sampling zone Area #7

Instrument used Pcc - 11T
Background β γ 52 dpm ±10
Background α 1 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-7-1A	2.25×10^{-5}	0**	7-1A	$< 4.50 \times 10^{-6}$	0
C-7-1B	"	0	7-1B	9.0×10^{-6}	0
C-7-2A	2.70×10^{-5}	0	7-2A	4.50×10^{-6}	0
C-7-2B	9.00×10^{-6}	0	7-2B	1.35×10^{-5}	0
C-7-3A	"	0	7-3A	1.80×10^{-5}	0
C-7-3B	1.80×10^{-5}	0	7-3B	4.50×10^{-6}	0
C-7-4A	2.70×10^{-5}	0	7-4A	2.70×10^{-5}	0
C-7-4B	1.80×10^{-5}	0	7-4B	9.0×10^{-6}	0
C-7-5A	2.25×10^{-5}	0	7-5A	2.25×10^{-5}	0
C-7-5B	2.70×10^{-5}	0	7-5B	3.15×10^{-5}	0
C-7-6A	9.00×10^{-6}	0	7-6A	2.25×10^{-5}	0
C-7-6B	"	0	7-6B	1.35×10^{-5}	0
C-7-7A	$< 4.50 \times 10^{-6}$	0			
C-7-7B	"	0			
C-7-8A	2.70×10^{-5}	0			
C-7-8B	1.8×10^{-5}	0			
C-7-9A	$< 4.50 \times 10^{-6}$	0			
C-7-9B	4.50×10^{-6}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

** Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date November 1978

Technician Ramón Pérez

Sampling zone Area # 8

Instrument used Pac-11T
Background β γ 50 dpm ±10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-8-1A	2.70×10^{-5}	0**	8-Cont.A	$< 4.50 \times 10^{-6}$	0
C-8-1B	3.15×10^{-5}	0	8-Cont.B	"	0
C-8-2A	1.35×10^{-5}	0	8-1A	5.85×10^{-5}	0
C-8-2B	3.15×10^{-5}	0	8-1B	$< 4.50 \times 10^{-6}$	0
C-8-3A	1.80×10^{-5}	0	8-2A	9.00×10^{-5}	0
C-8-3B	9.00×10^{-6}	0	8-2B	6.30×10^{-5}	
C-8-4A	2.70×10^{-5}	0			
C-8-4B	2.25×10^{-5}	0			
C-8-5A	$< 4.50 \times 10^{-6}$	0			
C-8-5B	4.95×10^{-5}	0			
C-8-6A	$< 4.50 \times 10^{-6}$	0			
C-8-6B	2.70×10^{-5}	0			
8-3A	4.95×10^{-5}	0			
8-3B	9.00×10^{-6}	0			
8-4A	2.70×10^{-5}	0			
8-4B	"	0			
8-5A	1.80×10^{-5}	0			
8-5B	$< 4.50 \times 10^{-6}$	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

APPENDIX 1A

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II
Date _____
Taken by Cintrón & Vega
Counted by Sánchez
Date counted 31 April 1978

☐ Notify _____ on ext. _____ of results. ☐ Notified.
☐ Send copy of report to: _____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☐ BETA-GAMMA
Background 30 ±10 c/m Geometry 2π PS-1T

Sample Number	Beta-Gamma	Alpha
1C	0 **	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	0	
18	0	
19	0	
20	0	
21	0	
22	0	
23	0	
24	0	
25	0	
26	0	
27	0	
28	0	

Identification of Samples:

Area A - Lab I-II El Verde

1A-1

Remarks: ** Zero (0) indicates counts bellow detection limits of Proportional Counter

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II ☐ Notify _____ on ext. _____ of results. ☐ Notified.

Date _____

Taken by Cintrón Vega

Counted by Sánchez

Date counted 31 April 1978

☐ Send copy of report to: _____ Code _____

To be counted for:
☐ ALPHA
Background _____ c/m Geometry _____
☐ BETA-GAMMA D5-1T
Background 30 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
29	0 **	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Sample Number	Beta-Gamma	Alpha
43	0	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
52	0	
53	0	
54	0	
55	0	
56	0	

Identification of Samples:

El Verde
Area A - Lab I-II

1A-2

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II
Date April '78
Taken by Cintrón + Vega
Counted by Sánchez
Date counted 31 April 1978

☐ Notify _____ on ext. _____ of results. ☐ Notified.
☐ Send copy of report to: _____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☐ BETA-GAMMA
Background 30 tID DS-1T c/m Geometry 2 π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
57	0 **	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	
64	0	
65	0	
66	0	
67	0	
68	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

El Verde
Area A - Lab I-II

1A-3

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____
Date April 78
Taken by A. Vega + Citrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1	0 **	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	0	
18	0	
19	0	
20	0	
21	0	

Identification of Samples:

El Verde Laboratory
Area B

1A-4

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____
Date April '78
Taken by A. Vega + Cintrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA
Background 29 to 10 c/m Geometry 2π DS-2

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
22	0 **	
23	0	
24	0	
25	0	
26	0	
27	0	
28	0	
29	0	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	

Sample Number	Beta-Gamma	Alpha
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Identification of Samples:

El Verde Laboratory

Area B

1A-5

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____
Date March '78
Taken by A. Vega + Cintrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
43	0**	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
52	0	
53	0	
54	0	
55	0	
56	0	

Sample Number	Beta-Gamma	Alpha
57	0	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	
64	0	
65	0	
66	0	
67	0	
68	0	
69	0	
70	0	

Identification of Samples:

El Verde Laboratory
Area - B

1A-6

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room ____
Date ____
Taken by A. Vega + Cintrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify ____ on ext. ____ of results. ☐ Notified.
☐ Send copy of report to: ____ Code ____

To be counted for
☐ ALPHA
Background ____ c/m Geometry ____
☒ BETA-GAMMA
Background 29 ± 10 c/m Geometry DS-2 / 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
71	0**	
72	0	
73	0	
74	0	
75	0	
76	0	
77	0	
78	0	
79	0	
80	0	
81	0	
82	0	
83	0	
84	0	

Sample Number	Beta-Gamma	Alpha
85	0	
86	0	
87	0	
88	0	
89	0	
90	0	
91	0	

Identification of Samples:

El Verde Laboratory

Area B

1A-7

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Storage Rm ☐ Notify _____ on ext. _____
Date Dec. 9, 91 of results. ☐ Notified.
Taken by Yega ☐ Send copy of report to:
Counted by Yega _____ Code _____
Date counted DEC, 10, 91

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA
Background 30 ± 10 c/m Geometry 2π

** Zero (0) Indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1A	0 **	
2A	0	
3A	0	
4A	0	
5A	0	
6A	0	
7A	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

El Verde Laboratory Area B
Storage Room

1A-8

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D
Date March '78
Taken by S. Gomez
Counted by Sánchez
Date counted April 3, 1978

☐ Notify _____ on ext. _____ of results. ☐ Notified.
☐ Send copy of report to: _____ Code _____

To be counted for
☐ ALPHA Background _____ c/m Geometry _____
☒ BETA-GAMMA Background $30^{\pm 10}$ c/m Geometry 2π DS-1T

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1	0**	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	0	
18	0	
19	0	
20	0	
21	0	
22	0	
23	0	
24	0	
25	0	
26	0	
27	0	
28	0	

Identification of Samples:

El Verde Lab Bldng.

Area C and Shops

1A-9

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D ☐ Notify _____ on ext. _____
Date March '78 of results. ☐ Notified.
Taken by Santiago Gomez ☐ Send copy of report to:
Counted by Feliciano _____ Code _____
Date counted April 3, 1978

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
29	0 **	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Sample Number	Beta-Gamma	Alpha
43	0	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
62	0	
53	0	
54	0	
55	0	
56	0	

Identification of Samples:

El Verde Lab building

Area C and Shops

1A-10

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area CD ☐ Notify _____ on ext. _____
Date March '78 of results. ☐ Notified.
Taken by S. Gomez ☐ Send copy of report to:
Counted by Feliciano _____ Code _____
Date counted April 3, 1978

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
57	0**	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

Smears El Verde Lab. Bldng

Area C and Shops

1A-11

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-7
Date March '78
Taken by S. Gomez
Counted by Sanchez
Date counted April 3, 1978

☐ Notify _____ on ext. _____ of results. ☐ Notified.
☐ Send copy of report to: _____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-1T
Background 30 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
64	0**	
65	0	
66	0	
67	0	
68	0	
69	0	
70	0	
71	0	
72	0	
73	0	
74	0	
75	0	
76	0	
77	0	

Sample Number	Beta-Gamma	Alpha
78	0	
79	0	
80	0	
81	0	
82	0	
83	0	
84	0	
85	0	
86	0	
87	0	
88	0	
89	0	
90	0	
91	0	

Identification of Samples:

El Verde Lab Building

Area C and Shops

1A-12

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D ☐ Notify _____ on ext. _____

Date _____ of results. ☐ Notified.

Taken by S. Gomez ☐ Send copy of report to: _____ Code _____

Counted by Sanchez & Felicians

Date counted April 3, 1978

To be counted for
☐ ALPHA Background _____ c/m Geometry _____
☒ BETA-GAMMA Background 30 ± 10 c/m Geometry 2π DS-1T

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
92	0 **	
93	0	
94	0	
95	0	
96	0	
97	0	
98	0	
99	0	
100	0	
101	0	
102	0	
103	0	
104	0	
105	0	

Sample Number	Beta-Gamma	Alpha
106	0	
107	0	
108	0	
109	0	
110	0	
111	0	
112	0	
113	0	
114	0	
115	0	

Identification of Samples:

El Verde Lab. building

Area C and Shops

1A-13

Remarks:

APPENDIX 2.

APPENDIX 2.

Soil Samples Analyzed in the Germanium Lithium Spectrometer *

VEGETATION

AREA	SAMPLE NO	CONTAMINATED	NOT CONTAMINATED
4	3	Cs-137	
2	6		X
2	5		X
8	4	X	
SOIL			
2	6 A & B		X
2	5 A & B		X
3	4 A & B		X
4	Base of tree	Cs-137	
4	Resin of tree	Cs-137	
5	5 A & B		X
5	6 A & B		X
7	7 A & B		X
7	8 A & B		X
8	1 A & B		X
8	2 A & B		X
8	6 A & B		x
8	Control 1 A & B		X

*Spectrometric analysis was made with the only purpose of detecting radioactive contaminants. No attempt was made to quantify any contaminant.

APPENDIX 3.

Soil Samples taken at the Experimental Station in order to establish background levels for comparison purposes.

Samples counted in the Gas Flow Proportional Counter

SAMPLE NO.	μ Ci/gm $\pm$ 2.3 X 10^{-5}
1	2.70×10^{-5}
2	5.40×10^{-5}
3	4.05×10^{-5}
4	1.80×10^{-5}

APPENDIX 4.

NRC Form 374
(2-81)

U.S. NUCLEAR REGULATORY COMMISSION

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MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter 1, Parts 30, 31, 32, 33, 34, 35, 36, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s); and to import such byproduct and source material. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. University of Puerto Rico Center for Energy and Environmental Research 2. Caparra Heights Station San Juan, Puerto Rico 00935	3. License number 52-19434-02 4. Expiration date March 31, 1987 5. Docket or Reference No.

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Hydrogen 3	A. Any	A. 4 curies
B. Cesium 137	B. Any	B. 1 millicurie

9. Authorized use

A. and B. For use in field experiments.

CONDITIONS

10. Licensed material shall be used only at Caribbean National Forest, Luguillo Forest, El Verde Research Station, Puerto Rico.

11. The licensee shall comply with the provisions of Title 10, Chapter 1, Code of Federal Regulations, Part 19, "Notices, Instructions and Reports to Workers; Inspections" and Part 20, "Standards for Protection Against Radiation."

12. Licensed material shall be used by, or under the supervision of, Jeffrey Carl Luvall.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
52-19434-02
Docket or Reference number

CONDITIONS

13. Licensed material shall not be used in or on human beings or in products distributed to the public.

14. A. Individuals involved in operations which utilize, at any one time, more than 100 millicuries of Hydrogen 3 in a non-contained form, other than metallic foil, shall have bioassays performed within one week following a single operation and at weekly intervals for continuing operations.

B. (1) Tritium shall not be used in such a manner as to cause any individual to receive a radiation exposure such that urinary excretion rates exceed 28 microcuries of tritium per liter when averaged over a calendar quarter.

(2) Urinalysis shall be performed at weekly intervals on all individuals who work in the restricted areas of facilities in which tritium is used. If the average concentration of tritium in urine for any single individual during a calendar quarter is less than 10 microcuries per liter, urinalysis may be performed on that individual at monthly intervals for the following calendar quarter and may continue at monthly intervals so long as the average concentration in the calendar quarter remains below 10 microcuries per liter. The urine specimen shall be collected on the same day of the week insofar as possible.

(3) A report of an average concentration in excess of the limit specified in B(1) above for any individual shall be filed, in writing, within thirty (30) days of the end of the calendar quarter with the Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, with a copy to the Regional Office of Inspection and Enforcement. The report shall contain the results of all urinalyses for the individual during the calendar quarter, the cause of the excessive concentrations, and the corrective steps taken or planned to assure against a recurrence.

(4) Any single urinalysis which discloses a concentration of greater than 50 microcuries per liter shall be reported, in writing, within seven (7) days of the licensee's receipt of the results, to the Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, with a copy to the U. S. Nuclear Regulatory Commission, Region II, Office of Inspection and Enforcement, 101 Marietta Street, Suite 3100, Atlanta, Georgia 30303.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
52-19434-02
Docket or Reference number

CONDITIONS

15. Except as specifically provided otherwise by this license, the licensee shall possess and use licensed material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in letter dated December 20, 1981. The Nuclear Regulatory Commission's regulations shall govern the licensee's statements in applications or letters, unless the statements are more restrictive than the regulations.

For the U.S. Nuclear Regulatory Commission

Date MAR 09 1982

By Material Licensing Branch
Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

NRC Form 374A
(12-81)

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE
SUPPLEMENTARY SHEET

PAGE 1 OF 1 PAGES

License number 52-19434-02

Docket or Reference number

Amendment No. 01

University of Puerto Rico
Center for Energy and Environmental
Research
Caparra Heights Station
San Juan, Puerto Rico 00935

In accordance with letter dated August 4, 1982, License Number 52-19434-02 is amended as follows:

Conditions 10. and 12. are amended to read:

10. Licensed material shall be used only at Caribbean National Forest, Luquillo Forest, El Verde Research Station, Puerto Rico.

12. Licensed material shall be used by, or under the supervision of, Laurence J. Tilly, Ph.D.

For the U.S. Nuclear Regulatory Commission

10-13-82

Original Signed By
Patricia C. Vacca
Material Licensing Branch

By

Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

OCT 13 1982

Date

10-15-82

FIGURES

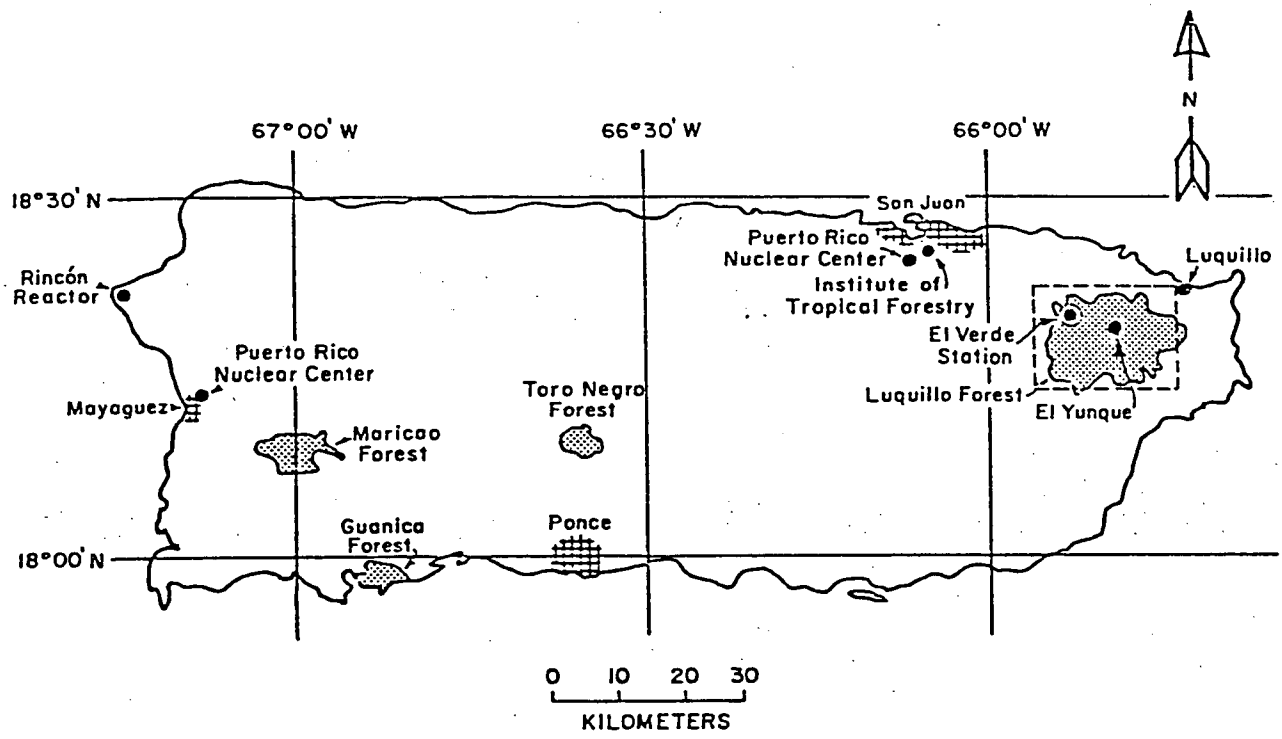
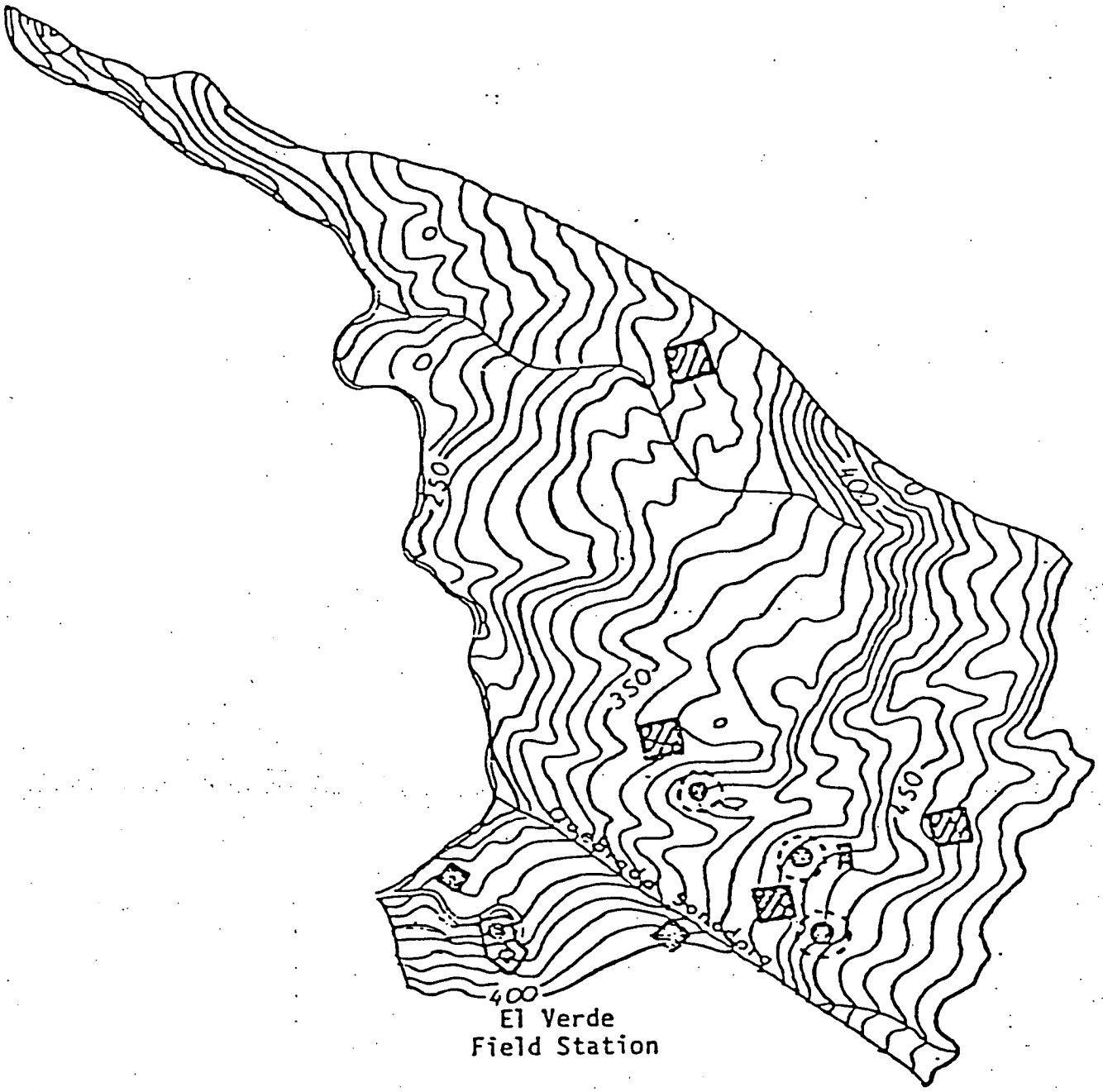


Fig. 1. Map of Puerto Rico Showing the Location of Luquillo Forest and El Verde Research Area.



Meteorological tower

Cycling and Transport study sites

U. S. Forest Service long term growth plots

AEC Experimental sites (1964-1970)

Fig. 1-A. Approximate boundary of the 156 acres under DOE-Forest Service Agreement

Fig. 2. Schematic Map of El Verde Research Area Showing the Cs-137 Radiation Center and Approximate Location of the 80m and 160m radii.

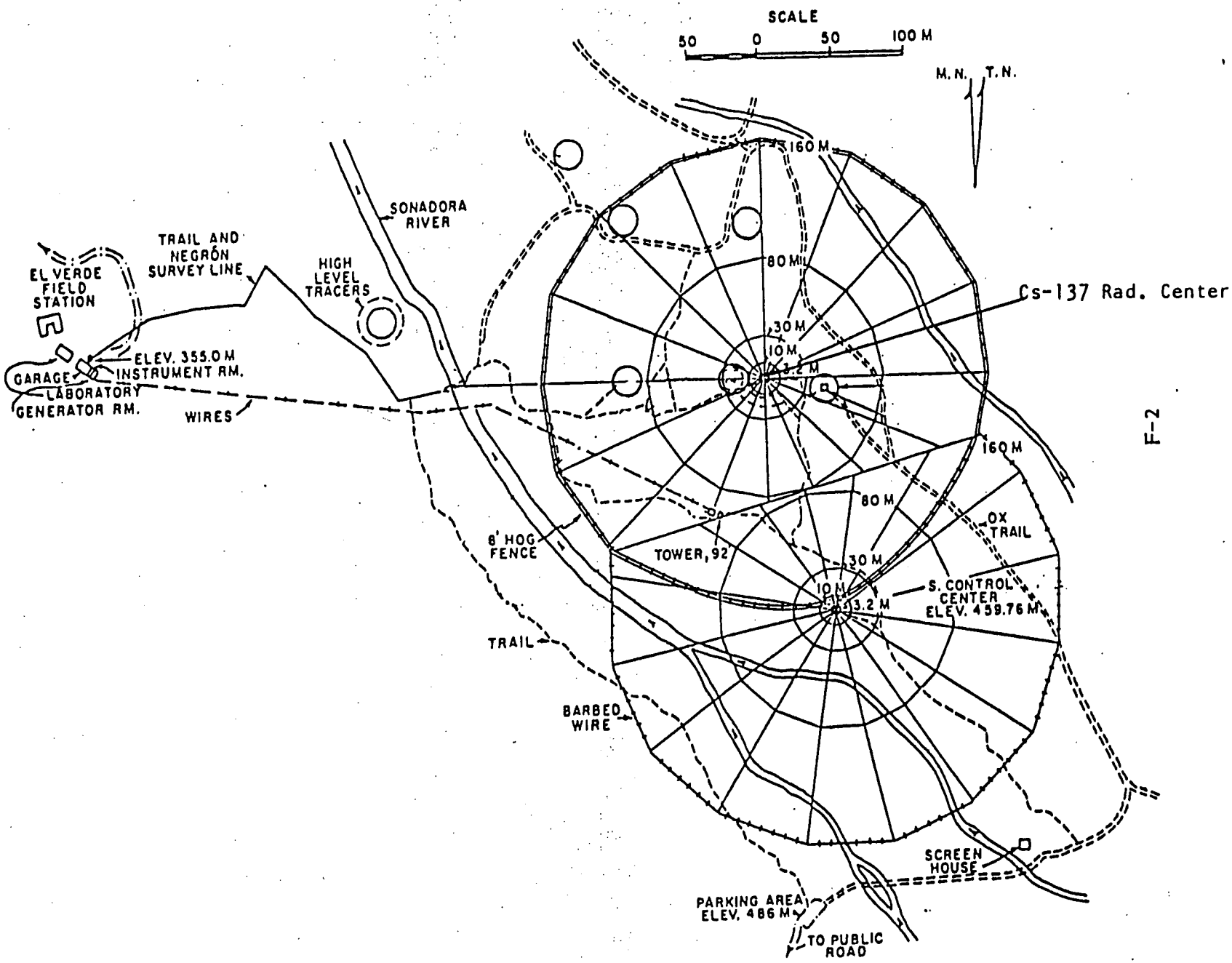


Fig. 3. Laboratory Area, El Verde Research Station.

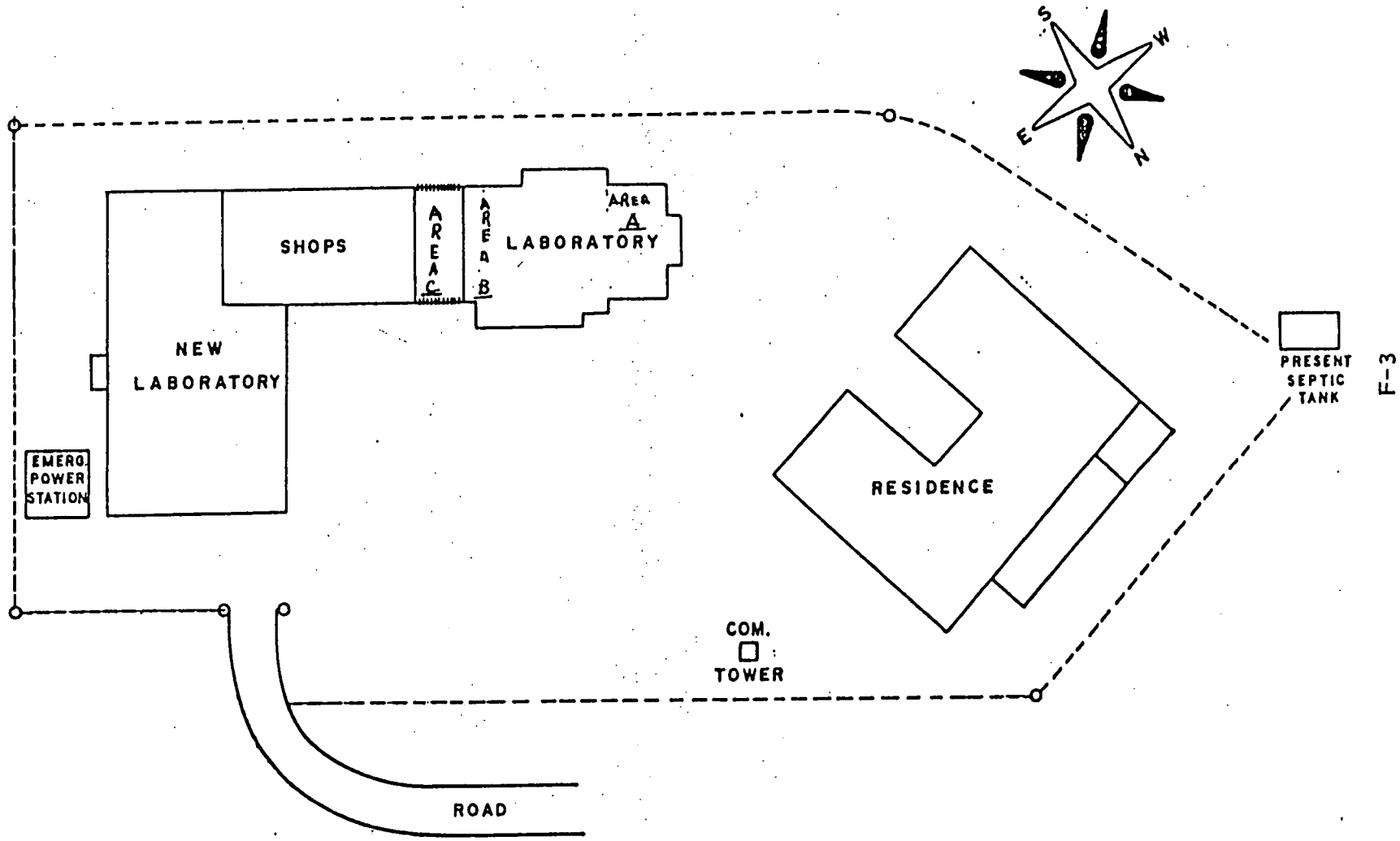


Fig. 4. Detail of Old Laboratory Building, Area A. Numbers Indicate Survey Points. See Appendix 1a for Results.

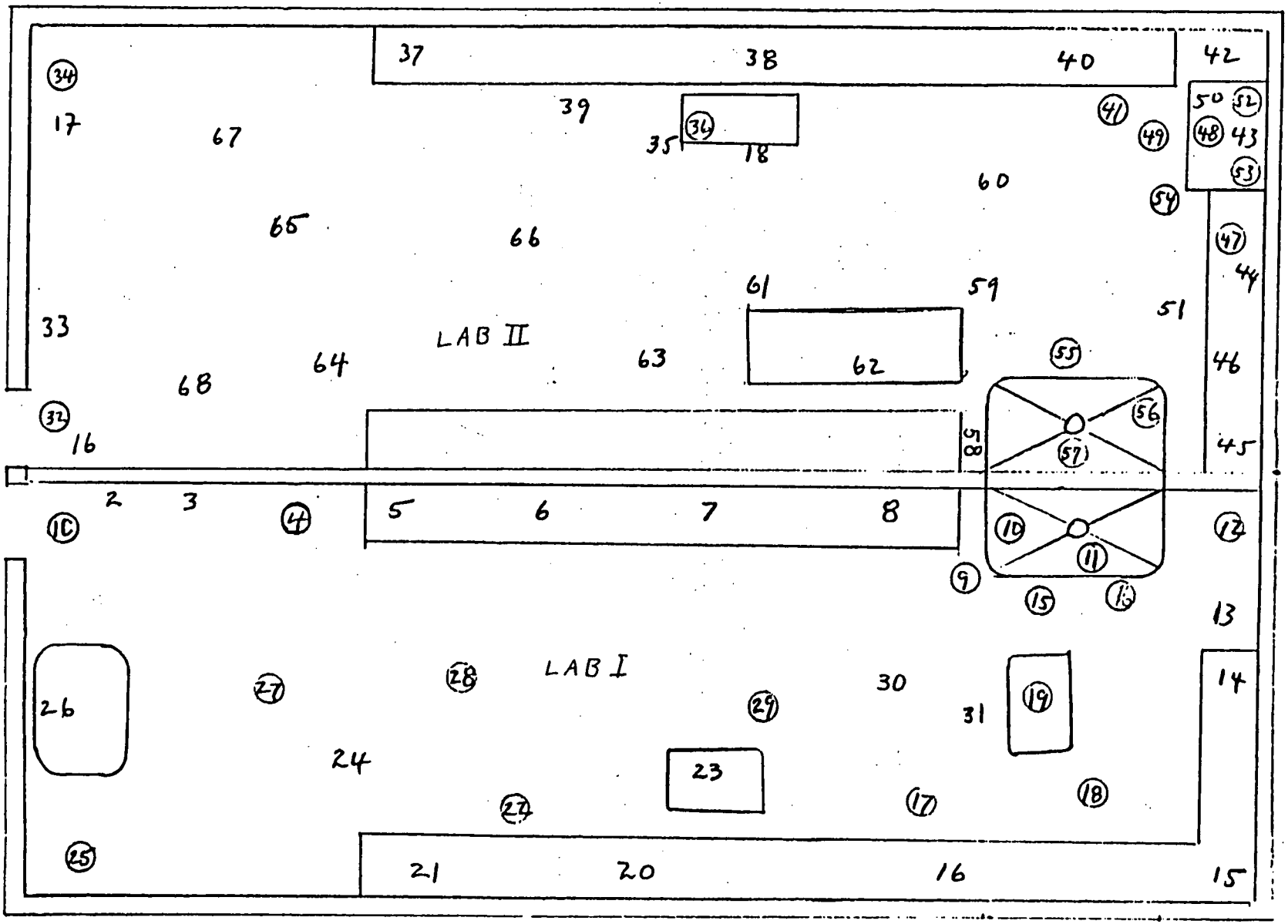


Fig. 5. Detail of Old Laboratory Building, Area B. Numbers Indicate Survey Points. See Appendix 1A for Results.

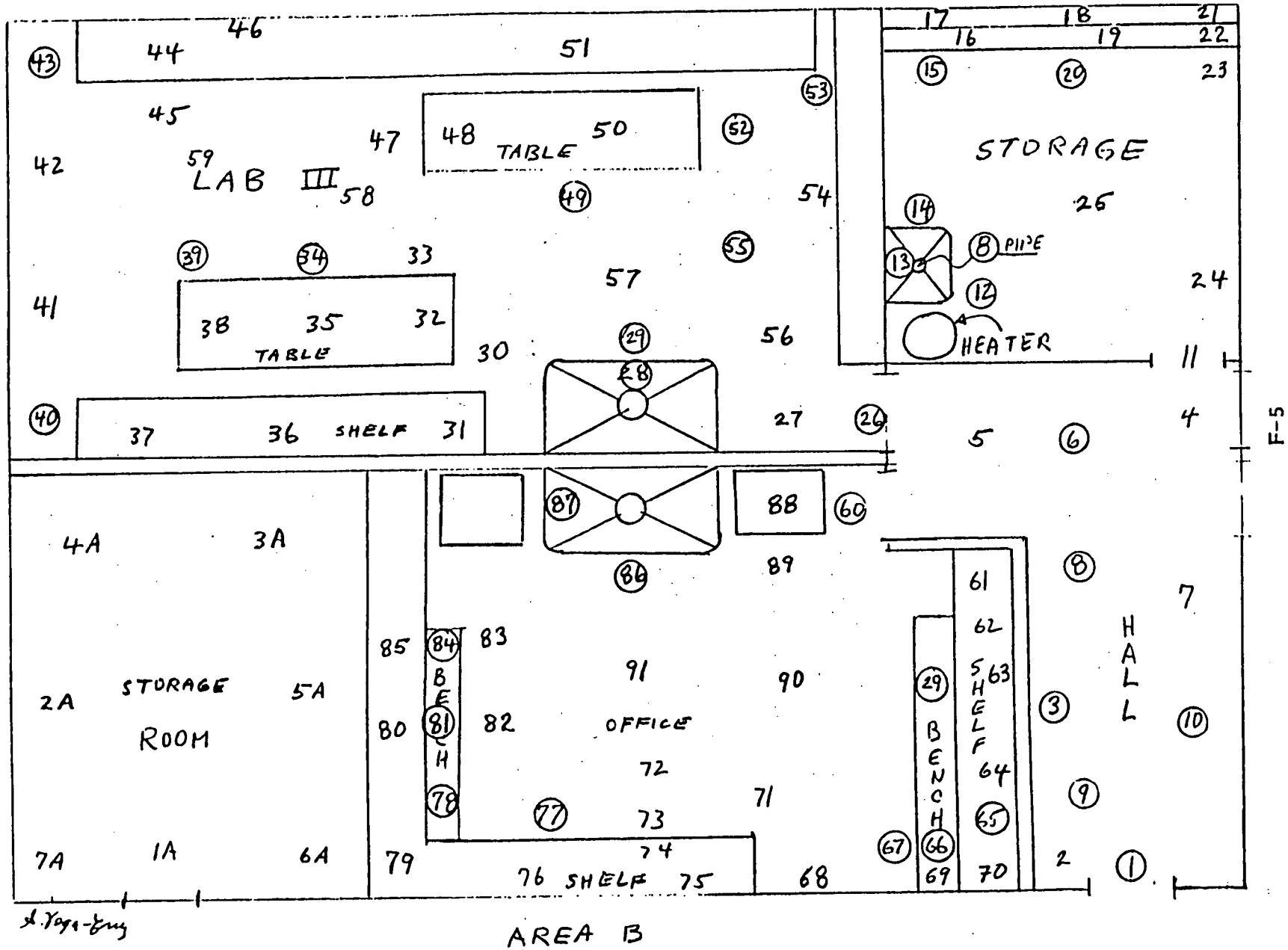


Fig. 6. Detail of Old Laboratory Building, Area C and Shops. Numbers Indicate Survey Points. See Appendix 1A for Results.

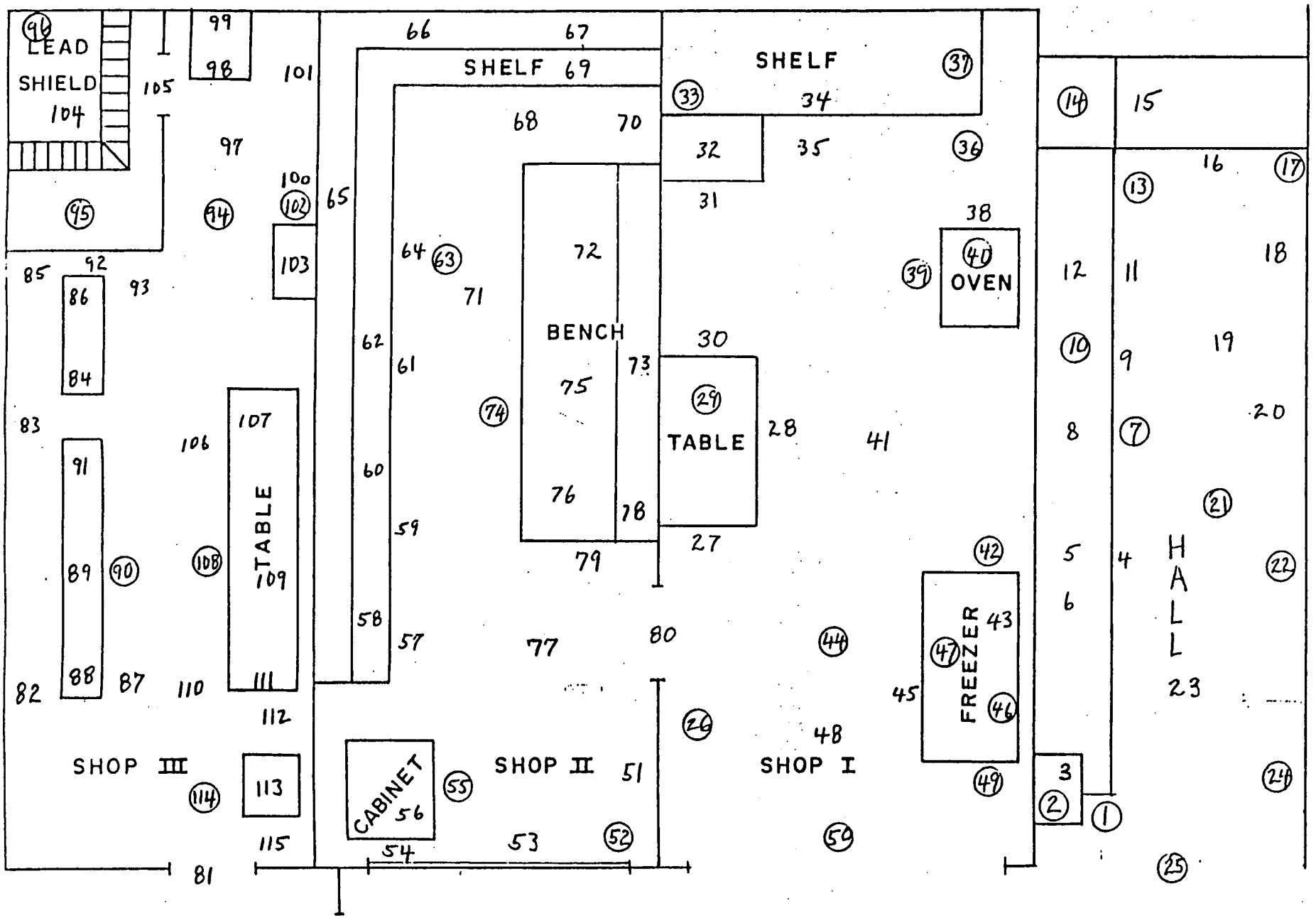


Fig. 7. Approximate Location of the Six Areas where Radiotracers were Used.

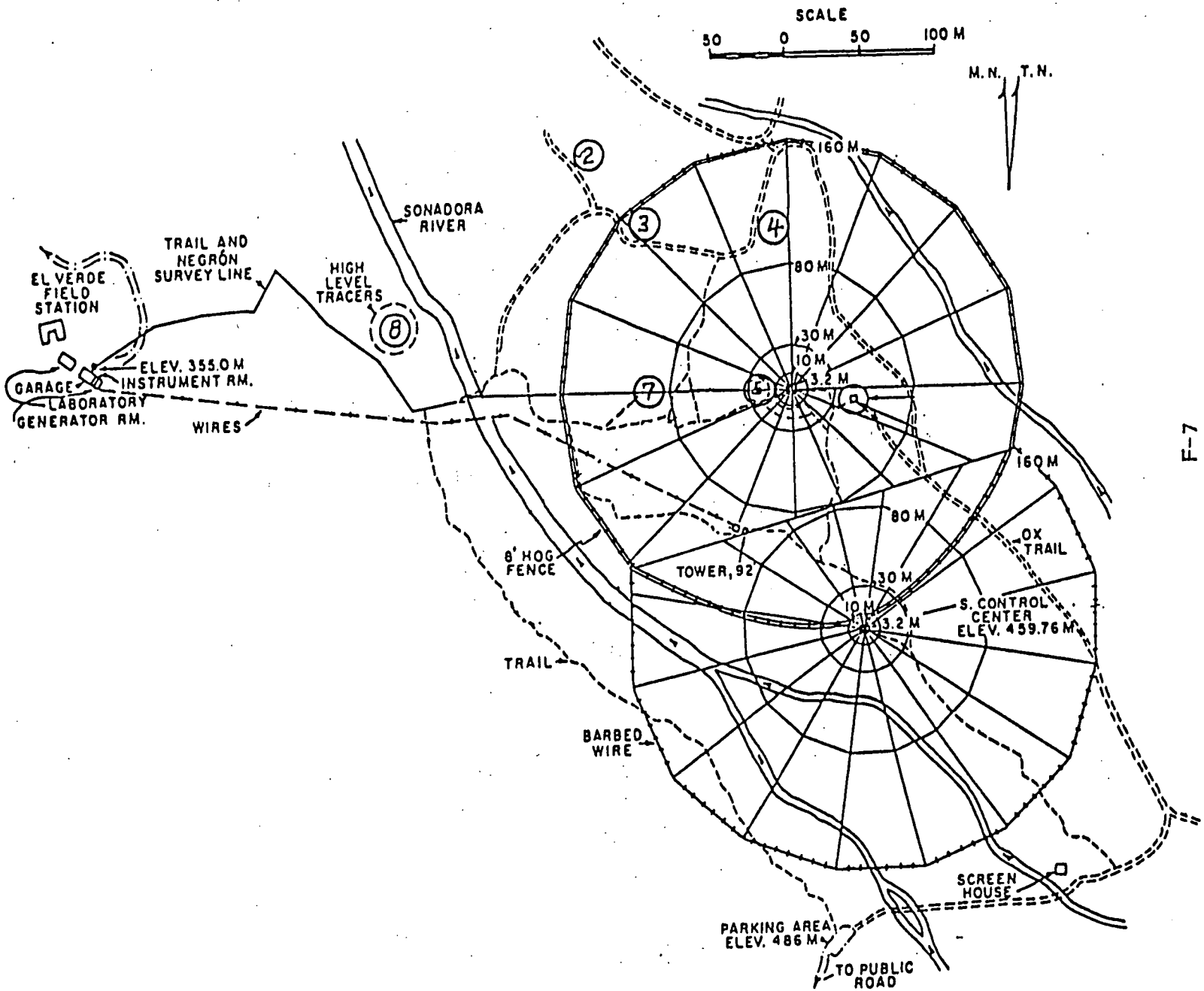
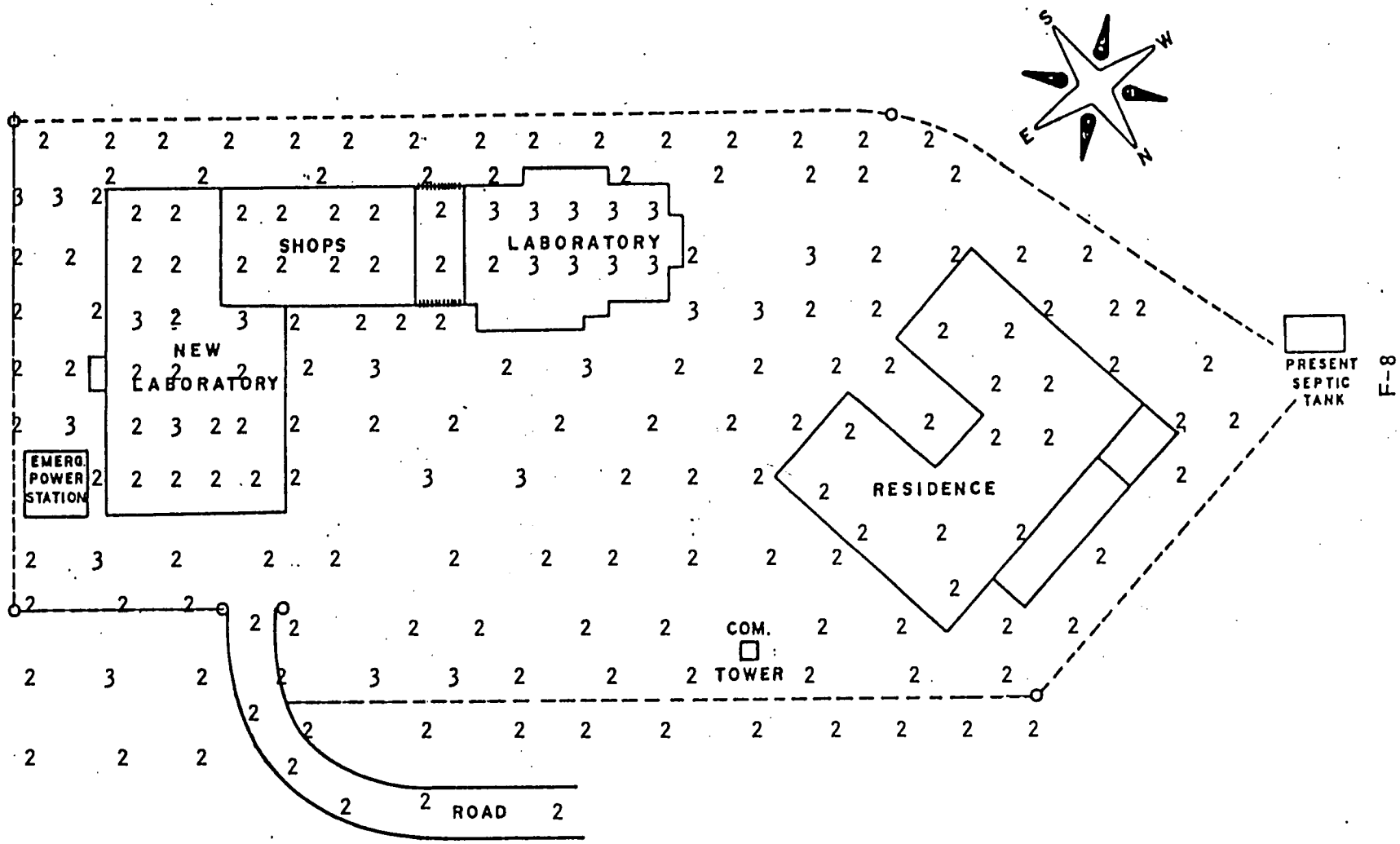


Fig. 8. Radiation Levels, Expressed in μR/hr, in the Laboratory Area.



El Verde Rain Forest ~2-7-VS Area #2 Back Ground 2.0μR

2-6 cont.

CONT. 2-3V	2.0μR
C-2-4SV	2.0μR
C-2-5	2.0μR
C-2-6	2.0μR
C-2-7	2.0μR
C-2-8	2.0μR
C-2-9	2.0μR
C-2-10	1.5μR

~2.0μR

~2-8-VS

2-5-SV

2-4-VS

2-3-SV Cont.

2-4-SV

2-2-SV

2-3 VS

~2-9-VS

2μR

2-5 S 16 JUN 79

1.5μR

2-6-S Jun 16-79

2-4VS

2-1

2μR

2μR

2-1-V

77° N.E.

~2-2VS cont.

~1.0μR

V-2 Cont.

20'

Area Diameter

~1.5μR

F-9

~2-1 Cont.

1.5μR

Tree #1 Connoll 1.5μR
Tree #5 " 1.5μR
Soil 1.5μR

See Appendix 1 for Results of Samples Analyzed.

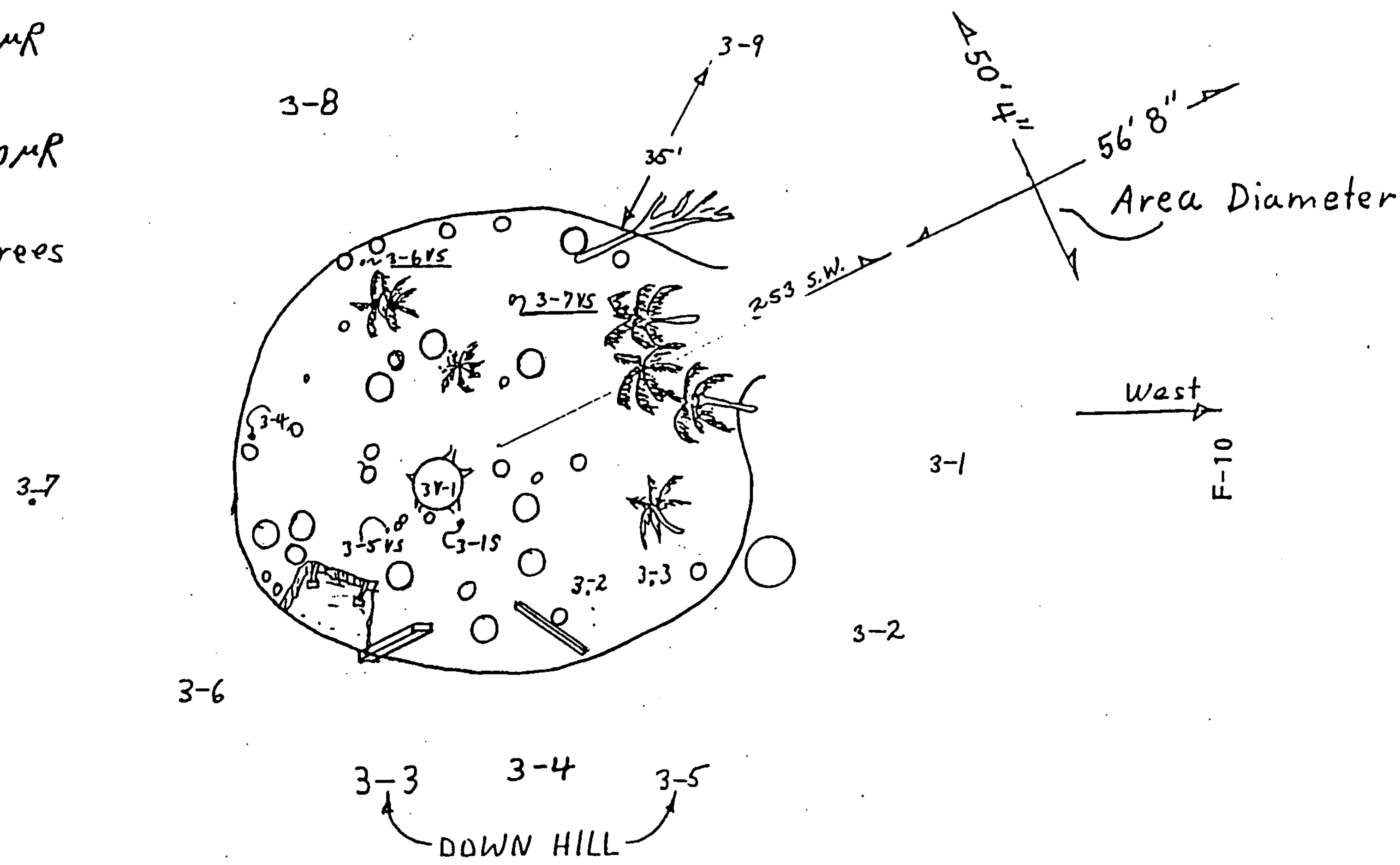
Area # 3 El Verde Rain Forest

soil	3-1-	2.0μR
	3-2	"
	3-3	"
	3-4	1.5μR
	3-5	"
	3-6	"
	3-7	2.0μR

1.5μR at all trees

Control Area

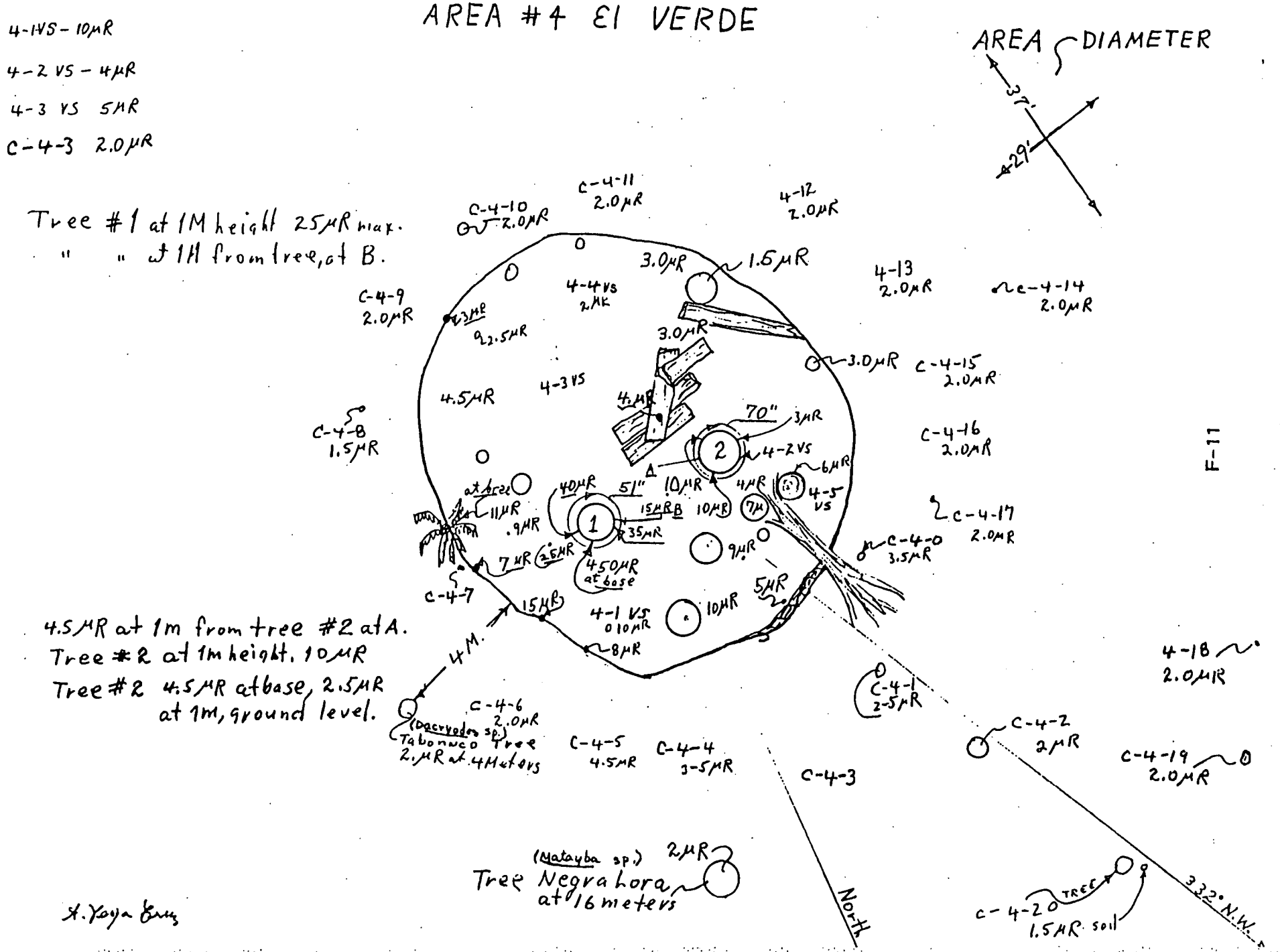
3-1	1.5μR
3-2	"
3-3	"
3-4	"
3-5	"
3-6	"
3-7	"
3-8	"
3-9	"



A. Vega Cruz

Fig. 11. Radiation Levels and Sampling Locations in Area. 4.

See Appendix 1 for Results of Samples Analyzed.



Area #5 El Verde

5-1 50μR
5-1-VS 30μR
5-2 VS 1.5μR

5-1-V 1.5μR
5-2 VS 2.0μR
5-3 VS 2.0μR
5-4 VS 2.0μR
5-5 VS 1.5μR
5-6 VS 1.5μR
5-7 VS 2.0μR

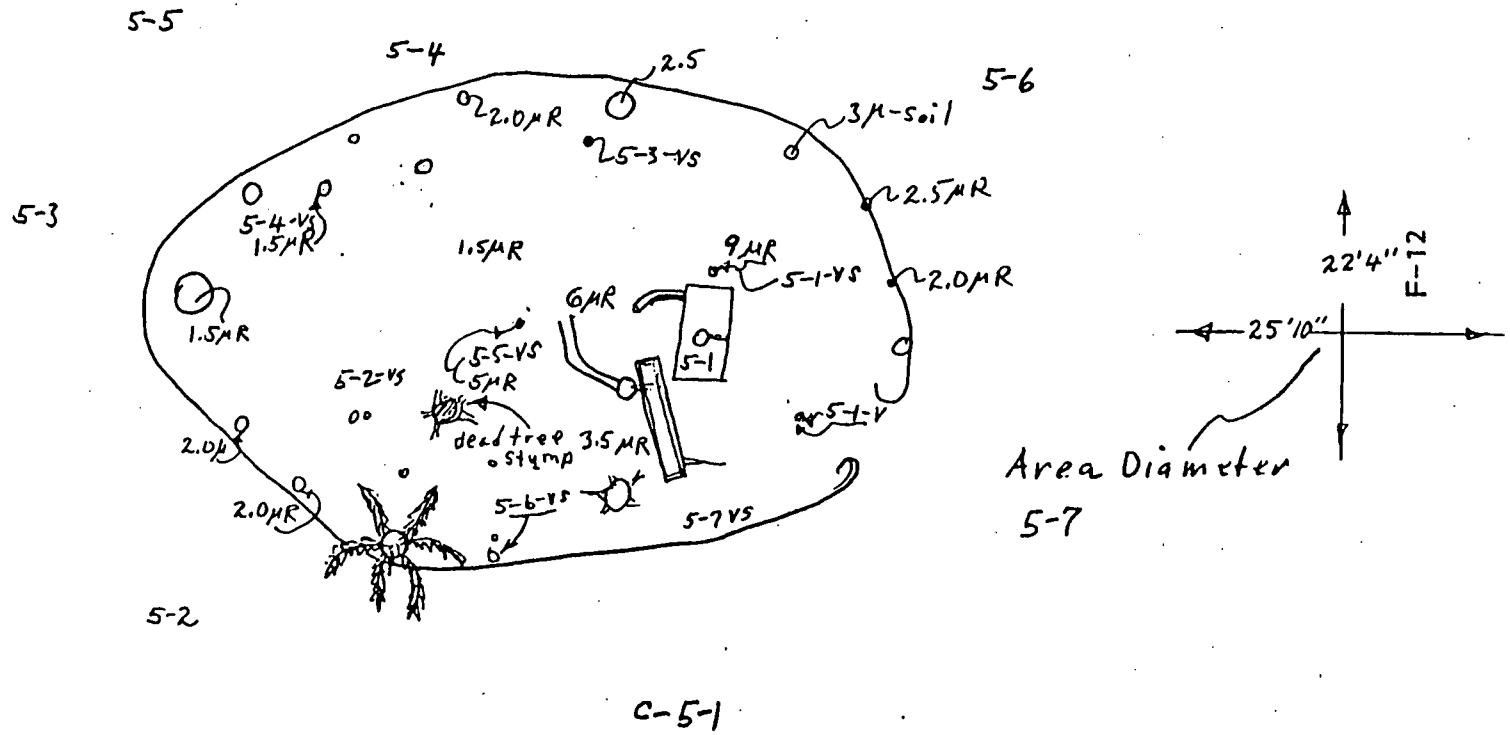


Fig. 12. Radiation Levels and Sampling Locations in Area 4.

See Appendix 1 for Results of Samples Analyzed.

S. Kaye & Eng

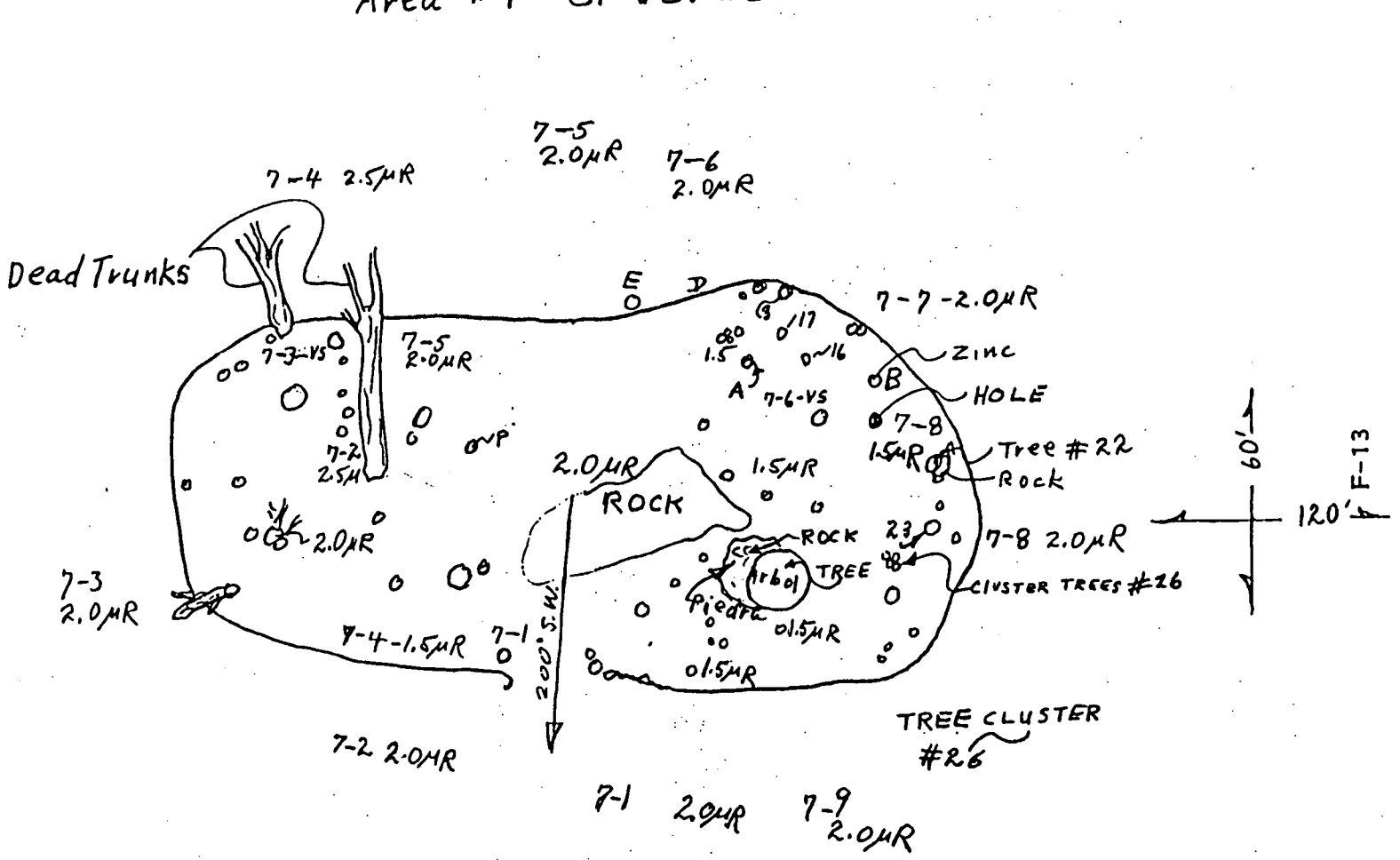


Fig. 13. Radiation Levels and Sampling Locations in Area 7.

See Appendix 1 for Results of Samples Analyzed.

Fig. 15. Radiation Levels After Decontamination of Area 8.

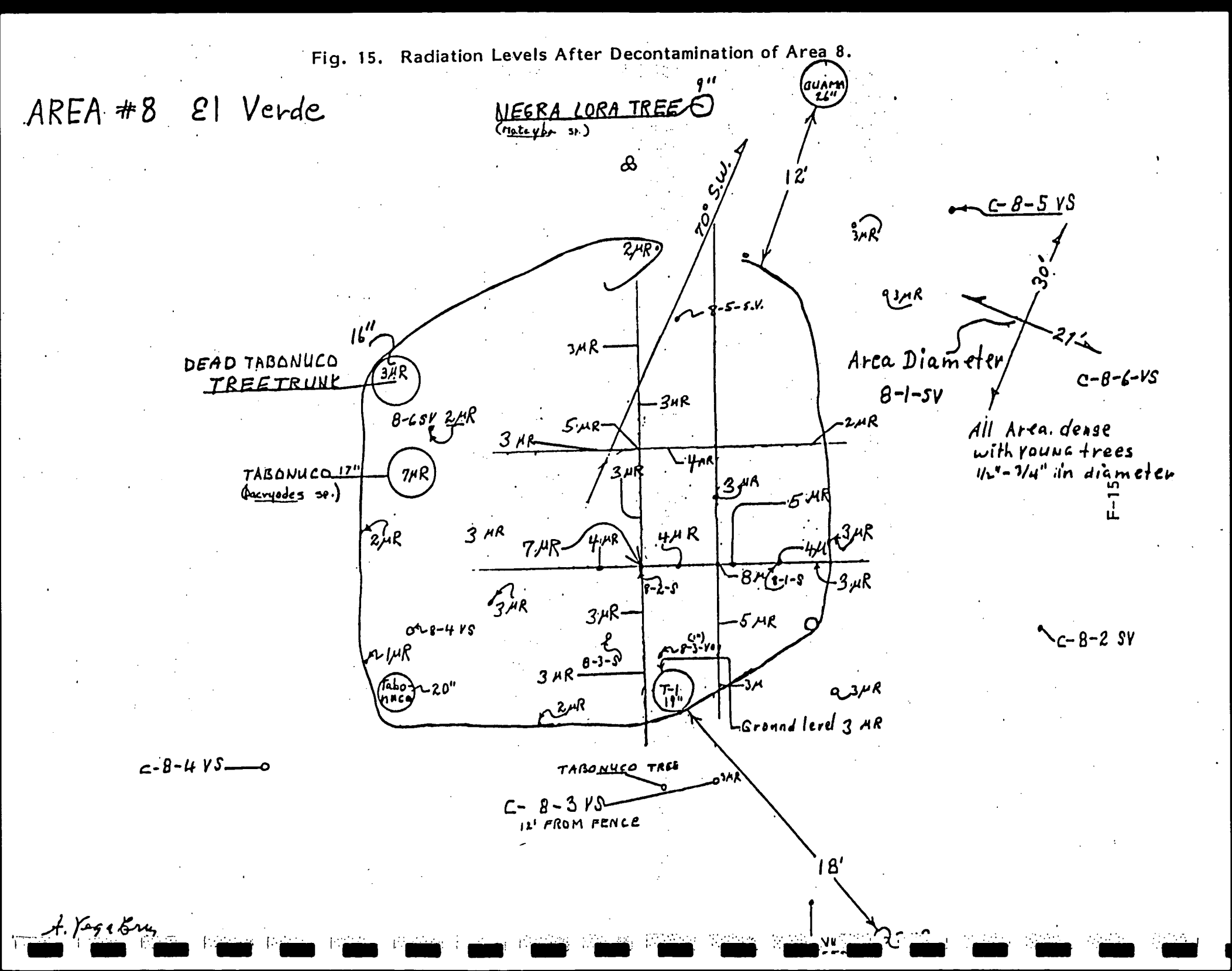
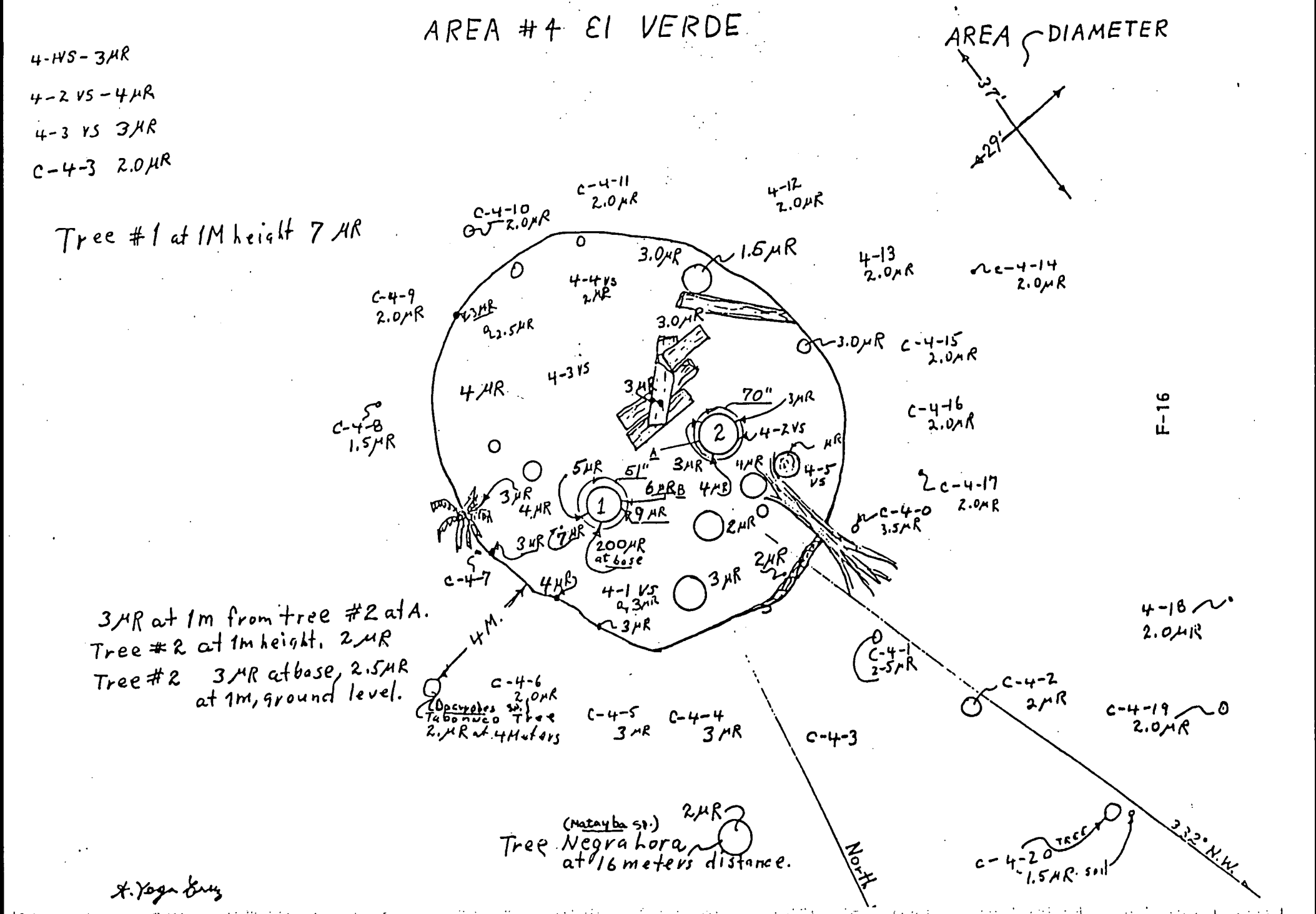


Fig. 16. Radiation Levels, at the present time, in Area 4.



LEAD-BASED PAINT INSPECTION FOR THE

EL VERDE CEER FACILITY
SAN LORENZO, PUERTO RICO

PREPARED FOR:

U.S. DEPARTMENT OF ENERGY
ENVIRONMENTAL RESTORATION PROGRAM
3 MAIN STREET
OAK RIDGE , TENNESSEE 37831

PREPARED BY:

DAC ENVIRONMENTAL OF PUERTO RICO, INC.
342 MADISON AVENUE
NEWYORK, NY 10173

PROJECT #PR-96-001

JULY 1996

TABLE OF CONTENTS

SECTION I

EXECUTIVE SUMMARY

DAC ENVIRONMENTAL OF PUERTO RICO, INC.
EXECUTIVE SUMMARY

The three types of readings obtained with this instrument are a screen, test, and confirm, DAC does not utilize the confirm. Each reading falls into three definitive ranges: negative, inconclusive, or positive. If the reading is negative or positive, no further testing is necessary. When the first reading, a screen, falls into an inconclusive range, a second reading called a test is taken. If the test is performed and falls into an inconclusive range, a paint chip sample is collected for analysis via Flame Atomic Absorption Spectrophotometry (FLAA) in accordance with NIOSH Method 7082.

Documentation of material condition was compiled. The conditions were categorized as follows: **Good** - All paint on surface is intact, **Fair** - Some paint is peeling or broken, **Poor** - Large amount of paint is peeling or broken.

Data and other information in this report is only valid for prevailing conditions during this investigation and will be held strictly confidential. DAC will not release this information without written permission except where required by law. DAC Environmental of Puerto Rico, Inc. does not accept responsibility for financial or health consequences for action or lack of action taken by our clients or their agents as a result of this lead in paint investigation report.

SECTION II

SURVEY AREA DISCUSSION & LBP COMPONENT SUMMARY

SURVEY AREA DISCUSSION/LBP COMPONENT SUMMARY

Lead-based painted components have been identified at both the El Verde CEER Facility. The following section summarizes the inspection survey findings. Exact locations, conditions, and colors of all components tested are listed in Section III of this report. Abatement response actions for positive lead-based painted components are listed in Section IV of this report.

EL VERDE CEER FACILITY, SAN LORENZO, P.R.

The El Verde CEER Facility was located in San Lorenzo, P.R. The facility consisted of five (5) buildings, the Original Laboratory Bldg. and Annex, Generator Bldg., Storage Bldg., Dormitory Bldg., and the Dining Hall Bldg., all of which were tested for LBP. The buildings currently were occupied by the University of Puerto Rico and was utilized as a agricultural research facility. The buildings ranged from 30-40 years of age and consisted of one story with primary building materials being concrete, wood, metal, and transite.

Based on the analytical results of the inspection, the following components associated with the El Verde CEER Facility were found to be **Positive** for the presence of LBP, >1 mg/cm^2 via XRF or >0.5% lead by weight via Flame Atomic Absorption Spectrophotometry (FLAA) in accordance with NIOSH Method 7082:

DORMITORY BUILDING

LOCATION	COMPONENTS
Interior/Exterior, Throughout	3' x 6' Wood Doors & Associated Casings (11 total)
Interior/Exterior, Men's Dorm Area	1.5' x 5' Wood Window Shutters (8 total)
Interior/Exterior, Throughout	3' x 5' Metal Window Vents (12 total)

***All other components within the facility tested negative for the presence of LBP.**

SECTION III

SAMPLE ANALYSIS
&
LIMITATIONS

SAMPLE ANALYSIS & LIMITATIONS

Spectrum Analyzer X-ray Fluorescence instruments such as the Scitec Map 3, report a calculated lead concentration that represents the concentration of the lead in the paint with minimal substrate contribution. The U.S. Department of Housing and Urban Development (HUD) regulatory limit for lead in paint is 1.0 milligrams per square centimeter (1.0 mg/cm^2). The manufacturer's precision levels for the screen, test, and confirm are 0.6 mg/cm^2, 0.3 mg/cm^2, and 0.15 mg/cm^2, respectively. The ranges used to determine if the lead concentrations are negative, inconclusive, or positive as defined by the HUD Lead-Based Paint Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing, September 1990, are listed below:

HUD Guideline (1.0 mg/cm^2)

READING	NEGATIVE	INCONCLUSIVE	POSITIVE
SCREEN	0 -<0.4	0.4 - 1.6	>1.6 - UP
TEST	0 - <0.8	0.8 - 1.2	>1.2 - UP
CONFIRM	0 - <0.85	0.85 - 1.15	>1.15 - UP

SECTION IV

SUMMARY OF SURFACES TESTED

(FIELD INSPECTION REPORTS & MAPS)

LEAD-BASED PAINT INSPECTION REPORT

CLIENT: DAC ENVIRONMENTAL OF PUERTO RICO, INC. **NUMBER OF ROOMS:** N/A **INSPECTOR:** E. MYSLOWSKI **DATE:** JULY 1, 1996

UNIT I.D.: EL VERDE CEER FACILITY **AGE OF BUILDING:** N/A **SITEC XRF SERIAL #:** AS081

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 001	GENERATOR BUILDING	EXTERIOR	METAL CEILING		0.0		GOOD	NO	GREEN		
SCREEN 002	GENERATOR BUILDING	EXTERIOR	METAL WINDOW VENT		0.0		GOOD	NO	WHITE		
SCREEN 003	GENERATOR BUILDING	INTERIOR	METAL WALL SUPPORT		-0.4		GOOD	NO	YELLOW		
SCREEN 004	LABORATORY BUILDING (ANNEX)	EXTERIOR	CONCRETE WALL (LOWER)		-1.2		FAIR	NO	LIGHT GREEN		
SCREEN 005	LABORATORY BUILDING (ANNEX)	EXTERIOR	CONCRETE STEP			0.6	FAIR	NO	DARK GREEN		
TEST 006	LABORATORY BUILDING (ANNEX)	EXTERIOR	CONCRETE STEP		0.4		FAIR	NO	DARK GREEN		
SCREEN 007	LABORATORY BUILDING (ANNEX)	EXTERIOR	METAL DOOR		-0.0		GOOD	NO	BROWN		
SCREEN 008	LABORATORY BUILDING (ANNEX)	EXTERIOR	WOOD WINDOW CASING		0.2		GOOD	NO	LIGHT GREEN		
SCREEN 009	LABORATORY BUILDING (ANNEX)	EXTERIOR	TRANSITE WALL (UPPER)		-0.4		GOOD	NO	LIGHT GREEN		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 010	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	CONCRETE AWNING			0.9	FAIR	NO	LIGHT GREEN		
TEST 011	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	CONCRETE AWNING		-0.1		GOOD	NO	LIGHT GREEN		
SCREEN 012	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	CONCRETE FLOOR		0.1		GOOD	NO	DARK GREEN		
SCREEN 013	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	METAL DOOR MOLDING		0.3		GOOD	NO	BROWN		
SCREEN 014	LABORATORY BUILDING (ANNEX)	ROOM 1	METAL DOOR MOLDING		0.1		GOOD	NO	TAN		
SCREEN 015	LABORATORY BUILDING (ANNEX)	ROOM 1	TRANSITE WALL		-0.1		GOOD	NO	TAN		
SCREEN 016	LABORATORY BUILDING (ANNEX)	ROOM 2	TRANSITE WALL		-0.2		GOOD	NO	TAN		
SCREEN 017	LABORATORY BUILDING (ANNEX)	ROOM 2	WOOD DOOR		-0.3		GOOD	NO	BROWN		
SCREEN 018	LABORATORY BUILDING (ANNEX)	ROOM 3	TRANSITE WALL		0.3		GOOD	NO	TAN		
SCREEN 019	LABORATORY BUILDING (ANNEX)	ROOM 3	WOOD DOOR		0.0		GOOD	NO	BROWN		
SCREEN 020	LABORATORY BUILDING (ANNEX)	ROOM 6	TRANSITE WALL		0.1		GOOD	NO	TAN		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 021	LABORATORY BUILDING (ANNEX)	ROOM 6	WOOD DOOR		-0.5		GOOD	NO	BROWN		
SCREEN 022	LABORATORY BUILDING (ANNEX)	CORRIDOR	TRANSITE WALL		-0.0		GOOD	NO	TAN		
SCREEN 023	LABORATORY BUILDING (ANNEX)	ROOM 5	TRANSITE WALL		-0.2		GOOD	NO	TAN		
SCREEN 024	LABORATORY BUILDING (ANNEX)	ROOM 5	WOOD DOOR		-0.0		GOOD	NO	BROWN		
SCREEN 025	LABORATORY BUILDING (ANNEX)	ROOM 4	TRANSITE WALL			0.6	GOOD	NO	TAN		
TEST 026	LABORATORY BUILDING (ANNEX)	ROOM 4	TRANSITE WALL		0.1		GOOD	NO	TAN		
SCREEN 027	LABORATORY BUILDING (ANNEX)	ROOM 7	TRANSITE WALL			0.6	GOOD	NO	TAN		
TEST 028	LABORATORY BUILDING (ANNEX)	ROOM 7	TRANSITE WALL		-0.1		GOOD	NO	TAN		
SCREEN 029	LABORATORY BUILDING (ANNEX)	ROOM 7	WOOD DOOR		-0.5		GOOD	NO	BROWN		
SCREEN 030	LABORATORY BUILDING (ANNEX)	ROOM 8	TRANSITE WALL		-0.5		GOOD	NO	TAN		
SCREEN 031	LABORATORY BUILDING (ANNEX)	ROOM 8	WOOD DOOR		-0.2		GOOD	NO	BROWN		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 032	LABORATORY BUILDING (ANNEX)	BATH	TRANSITE WALL		-0.1		GOOD	NO	TAN		
SCREEN 033	LABORATORY BUILDING (ANNEX)	BATH	WOOD DOOR		-0.5		GOOD	NO	BROWN		
SCREEN 034	LABORATORY BUILDING (ORIGINAL)	CORRIDOR	CONCRETE WALL		-0.8		GOOD	NO	TAN		
SCREEN 035	LABORATORY BUILDING (ORIGINAL)	COMPUTER ROOM	TRANSITE WALL		-0.1		GOOD	NO	TAN		
SCREEN 036	LABORATORY BUILDING (ORIGINAL)	COMPUTER ROOM	WOOD WINDOW CASING			0.4	GOOD	NO	TAN		
TEST 037	LABORATORY BUILDING (ORIGINAL)	COMPUTER ROOM	WOOD WINDOW CASING		0.0		GOOD	NO	TAN		
SCREEN 038	LABORATORY BUILDING (ORIGINAL)	COMPUTER ROOM	WOOD DOOR CASING		0.1		GOOD	NO	TAN		
SCREEN 039	LABORATORY BUILDING (ORIGINAL)	HERB ROOM	WOOD DOOR CASING		-0.1		GOOD	NO	TAN		
SCREEN 040	LABORATORY BUILDING (ORIGINAL)	HERB ROOM	WOOD DOOR		-0.4		GOOD	NO	BROWN		
SCREEN 041	LABORATORY BUILDING (ORIGINAL)	HERB ROOM	CONCRETE WALL		-0.4		GOOD	NO	WHITE		
SCREEN 042	LABORATORY BUILDING (ORIGINAL)	HERB ROOM	CONCRETE CEILING			1.0	GOOD	NO	WHITE		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
TEST 043	LABORATORY BUILDING (ORIGINAL)	HERB ROOM	CONCRETE CEILING		-0.2		GOOD	NO	WHITE		
SCREEN 044	LABORATORY BUILDING (ORIGINAL)	CORRIDOR	METAL VENT		-0.1		GOOD	NO	TAN		
SCREEN 045	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	METAL DOOR		-0.0		GOOD	NO	BROWN		
SCREEN 046	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	CONCRETE WALL		-0.6		GOOD	NO	LIGHT GREEN		
SCREEN 047	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	WOOD DOOR		-0.2		GOOD	NO	BROWN		
SCREEN 048	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	WOOD DOOR CASING		-0.3		GOOD	NO	BROWN		
SCREEN 049	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	CONCRETE CEILING			1.3	GOOD	NO	LIGHT GREEN		
TEST 050	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	CONCRETE CEILING		-0.2		GOOD	NO	LIGHT GREEN		
SCREEN 051	LABORATORY BUILDING (ORIGINAL)	SAMPLE STORAGE	WOOD PARTITION WALL		-0.1		GOOD	NO	LIGHT GREEN		
SCREEN 052	LABORATORY BUILDING (ORIGINAL)	MAINTENANCE WORKSHOP	CONCRETE WALL		0.2		GOOD	NO	YELLOW		
SCREEN 053	LABORATORY BUILDING (ORIGINAL)	MAINTENANCE WORKSHOP	CONCRETE CEILING		-0.5		GOOD	NO	YELLOW		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 054	LABORATORY BUILDING (ORIGINAL)	STORAGE CAGE	CONCRETE WALL		-0.2		GOOD	NO	YELLOW		
SCREEN 055	LABORATORY BUILDING (ORIGINAL)	EXTERIOR STORAGE CAGE	WOOD SCREEN DOOR		0.3		GOOD	NO	YELLOW		
SCREEN 056	LABORATORY BUILDING (ORIGINAL)	LAB 2	CONCRETE WALL		0.0		GOOD	NO	TAN		
SCREEN 057	LABORATORY BUILDING (ORIGINAL)	LAB 2	CONCRETE CEILING		0.2		GOOD	NO	TAN		
SCREEN 058	LABORATORY BUILDING (ORIGINAL)	LAB 2	WOOD DOOR		0.2		GOOD	NO	BROWN		
SCREEN 059	LABORATORY BUILDING (ORIGINAL)	LAB 2	WOOD DOOR CASING		-0.4		GOOD	NO	TAN		
SCREEN 060	LABORATORY BUILDING (ORIGINAL)	JANITOR STORAGE ROOM	CONCRETE WALL			1.1	GOOD	NO	TAN		
TEST 061	LABORATORY BUILDING (ORIGINAL)	JANITOR STORAGE ROOM	CONCRETE WALL		0.6		GOOD	NO	TAN		
SCREEN 062	LABORATORY BUILDING (ORIGINAL)	LAB 4	CONCRETE WALL		-0.0		GOOD	NO	TAN		
SCREEN 063	LABORATORY BUILDING (ORIGINAL)	LAB 3	CONCRETE WALL		-0.4		GOOD	NO	TAN		
SCREEN 064	LABORATORY BUILDING (ORIGINAL)	LAB 3	CONCRETE CEILING			0.8	FAIR	NO	TAN		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
TEST 065	LABORATORY BUILDING (ORIGINAL)	LAB 3	CONCRETE CEILING		0.1		FAIR	NO	TAN		
SCREEN 066	LABORATORY BUILDING (ORIGINAL)	LAB 3	WOOD DOOR		0.3		GOOD	NO	BROWN		
SCREEN 067	LABORATORY BUILDING (ORIGINAL)	LAB 3	WOOD DOOR CASING		-0.3		GOOD	NO	BROWN		
SCREEN 068	LABORATORY BUILDING (ORIGINAL)	LAB 1	CONCRETE WALL			0.4	GOOD	NO	LIGHT GREEN		
TEST 069	LABORATORY BUILDING (ORIGINAL)	LAB 1	CONCRETE WALL		-0.3		GOOD	NO	LIGHT GREEN		
SCREEN 070	LABORATORY BUILDING (ORIGINAL)	LAB 1	CONCRETE CEILING			0.5	GOOD	NO	LIGHT GREEN		
TEST 071	LABORATORY BUILDING (ORIGINAL)	LAB 1	CONCRETE CEILING		0.2		GOOD	NO	LIGHT GREEN		
SCREEN 072	LABORATORY BUILDING (ORIGINAL)	STORAGE	CONCRETE WALL		-0.1		GOOD	NO	LIGHT GREEN		
SCREEN 073	LABORATORY BUILDING (ORIGINAL)	EXTERIOR	CONCRETE WALL		-0.8		GOOD	NO	LIGHT GREEN		
SCREEN 074	DORMITORY	EXTERIOR	CONCRETE WALL (UPPER)		0.0		GOOD	NO	LIGHT GREEN		
SCREEN 075	DORMITORY	EXTERIOR	CONCRETE WALL (LOWER)				GOOD	NO	LIGHT GREEN		BAD SPECTRA

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 076	DORMITORY	EXTERIOR	CONCRETE WALL (LOWER)			1.0	GOOD	NO	DARK GREEN		
TEST 077	DORMITORY	EXTERIOR	CONCRETE WALL (LOWER)		0.3		GOOD	NO	DARK GREEN		
SCREEN 078	DORMITORY	EXTERIOR	METAL VENT			1.3	GOOD	NO	DARK GREEN		
TEST 079	DORMITORY	EXTERIOR	METAL VENT		0.6		GOOD	NO	DARK GREEN		
SCREEN 080	DORMITORY	EXTERIOR	CONCRETE STEP		-1.5		GOOD	NO	DARK GREEN		
SCREEN 081	DORMITORY	EXTERIOR	WOOD DOOR		-1.5		GOOD	NO	DARK GREEN		
SCREEN 082	DORMITORY	EXTERIOR	WOOD DOOR CASING		-0.5		GOOD	NO	DARK GREEN		
SCREEN 083	DORMITORY	EXTERIOR	WOOD WINDOW CASING		0.2		GOOD	NO	DARK GREEN		
SCREEN 084	DORMITORY	ROOM 1 EXTERIOR	WOOD DOOR	2.5			GOOD	NO	DARK GREEN		
SCREEN 085	DORMITORY	ROOM 1 EXTERIOR	WOOD DOOR JAMB/ CASING	2.5			GOOD	NO	DARK GREEN		
SCREEN 086	DORMITORY	ROOM 1	CONCRETE WALL		-0.5		GOOD	NO	WHITE		

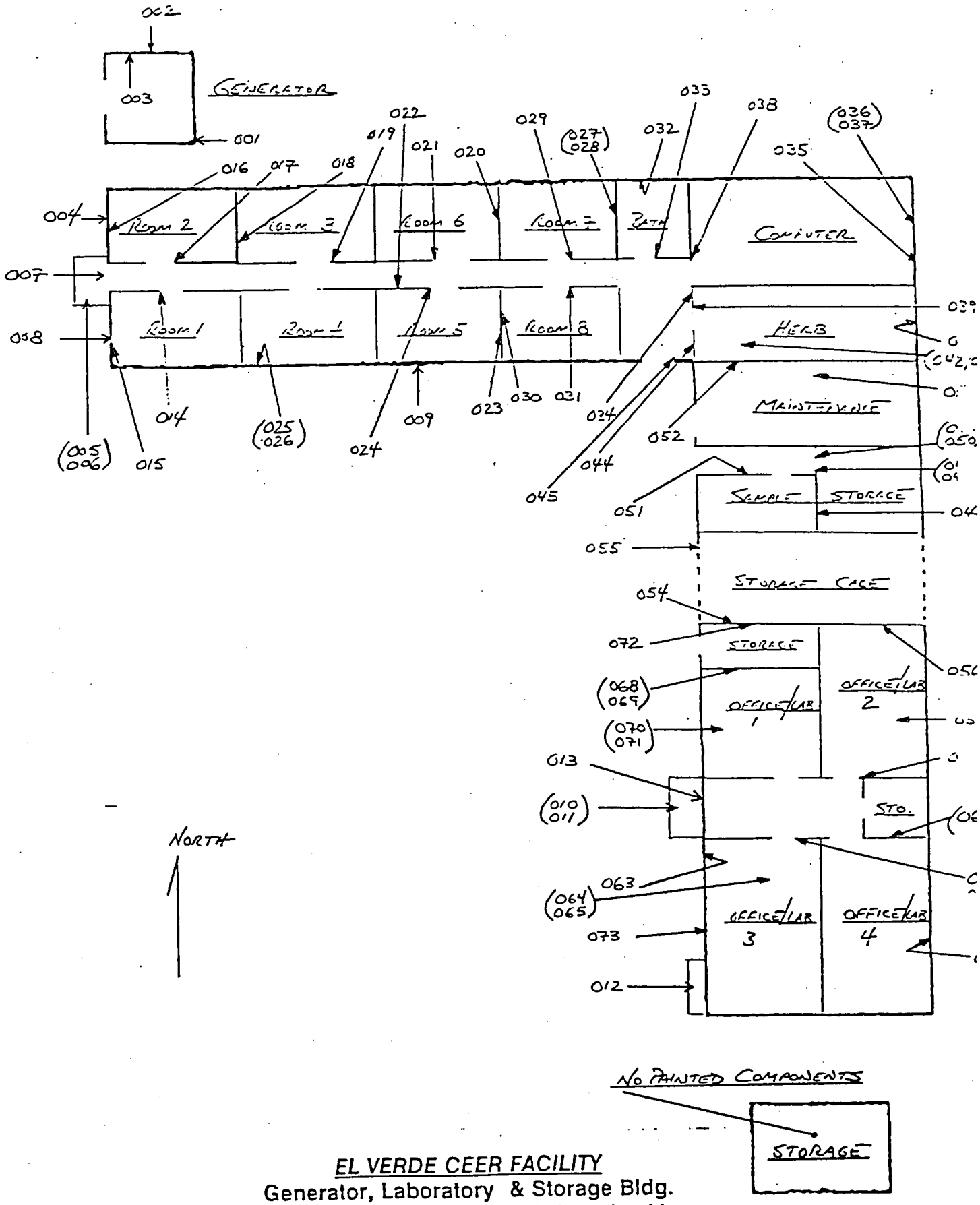
ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 087	DORMITORY	ROOM 1	BATH WOOD DOOR CASING	2.8			GOOD	NO	DARK GREEN		
SCREEN 088	DORMITORY	ROOM 1	CLOSET WOOD DOOR JAMB	3.6			GOOD	NO	WHITE		
SCREEN 089	DORMITORY	ROOM 1	CLOSET CONCRETE WALL			0.6	GOOD	NO	WHITE		
TEST 090	DORMITORY	ROOM 1	CLOSET CONCRETE WALL		-0.1		GOOD	NO	WHITE		
SCREEN 091	DORMITORY	ROOM 1	CLOSET WOOD SHELF			0.4	GOOD	NO	WHITE		
TEST 092	DORMITORY	ROOM 1	CLOSET WOOD SHELF		0.3		GOOD	NO	WHITE		
SCREEN 093	DORMITORY	ROOM 1	CONCRETE CEILING		0.1		GOOD	NO	WHITE		
SCREEN 094	DORMITORY	BATHROOM	CLOSET WOOD DOOR CASING	3.0			GOOD	NO	WHITE		
SCREEN 095	DORMITORY	BATHROOM	CONCRETE WALL		-0.6		GOOD	NO	WHITE		
SCREEN 096	DORMITORY	BATHROOM	CONCRETE CEILING		-0.8		GOOD	NO	WHITE		
SCREEN 097	DORMITORY	BATHROOM	CLOSET WOOD SHELF			0.6	GOOD	NO	WHITE		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
TEST 098	DORMITORY	BATHROOM	CLOSET WOOD SHELF		0.3		GOOD	NO	WHITE		
SCREEN 099	DORMITORY	ROOM 2	WOOD DOOR	3.2			GOOD	NO	DARK GREEN		
SCREEN 100	DORMITORY	ROOM 2	CONCRETE WALL		0.2		GOOD	NO	WHITE		
SCREEN 101	DORMITORY	ROOM 2	CONCRETE CEILING			0.8	GOOD	NO	WHITE		
TEST 102	DORMITORY	ROOM 2	CONCRETE CEILING		-0.4		GOOD	NO	WHITE		
SCREEN 103	DORMITORY	ROOM 2	WOOD DOOR CASING	3.4			GOOD	NO	WHITE		
SCREEN 104	DORMITORY	EXTERIOR MEN'S DORM AREA	WOOD SHUTTER	4.0			GOOD	NO	DARK GREEN		
SCREEN 105	DORMITORY	EXTERIOR	CONCRETE CEILING		-0.2		GOOD	NO	LIGHT GREEN		
SCREEN 106	DORMITORY	EXTERIOR	METAL VENT			1.2	GOOD	NO	DARK GREEN		
TEST 107	DORMITORY	EXTERIOR	METAL VENT			0.9	GOOD	NO	DARK GREEN		
SCREEN 108	***DORMITORY***	***EXTERIOR***	***METAL VENT***			***1.2***	***GOOD***	***YES SAMPLE 001***	***DARK GREEN***	***3.01% POSITIVE***	

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 109	DORMITORY	EXTERIOR	METAL VENT			0.7	GOOD	NO	DARK GREEN		
SCREEN 110	DORMITORY	MEN'S DORM AREA	WOOD DOOR	5.0			GOOD	NO	DARK GREEN		
SCREEN 111	DORMITORY	MEN'S DORM AREA	METAL WINDOW VENT		-0.0		GOOD	NO	LIGHT GREEN		
SCREEN 112	DORMITORY	MEN'S DORM AREA	BATH WOOD DOOR JAMB		0.2		GOOD	NO	DARK GREEN		
SCREEN 113	DORMITORY	MEN'S DORM AREA	BATH WOOD DOOR		0.1		GOOD	NO	WHITE		
SCREEN 114	DORMITORY	MEN'S DORM AREA	BATH CONCRETE WALL		-0.6		GOOD	NO	WHITE		
SCREEN 115	DORMITORY	MEN'S DORM AREA	BATH WOOD CEILING		0.2		GOOD	NO	WHITE		
SCREEN 116	DORMITORY	MEN'S DORM AREA	CONCRETE WALL			0.5	GOOD	NO	WHITE		
TEST 117	DORMITORY	MEN'S DORM AREA	CONCRETE WALL		-0.2		GOOD	NO	WHITE		
SCREEN 118	DORMITORY	MEN'S DORM AREA	CONCRETE CEILING		0.3		GOOD	NO	WHITE		
SCREEN 119	DORMITORY (ORIGINAL)	ROOM 3	CONCRETE WALL		-0.0		GOOD	NO	WHITE		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
SCREEN 120	DORMITORY	ROOM 3	BATH WOOD DOOR		-0.4		GOOD	NO	WHITE		
SCREEN 121	DORMITORY	ROOM 3	BATH CONCRETE WALL		-0.3		GOOD	NO	WHITE		
SCREEN 122	DORMITORY	ROOM 3	BATH WOOD DOOR CASING		-1.0		GOOD	NO	WHITE		
SCREEN 123	DORMITORY	ROOM 3	CONCRETE CEILING		0.3		GOOD	NO	WHITE		
SCREEN 124	DORMITORY	KITCHEN	WOOD DOOR	3.9			GOOD	NO	DARK GREEN		
SCREEN 125	DORMITORY	KITCHEN	CLOSET WOOD DOOR CASING	1.8			GOOD	NO	WHITE		
SCREEN 126	DORMITORY	KITCHEN	CONCRETE WALL		0.2		GOOD	NO	WHITE		
SCREEN 127	DORMITORY	KITCHEN	CONCRETE CEILING			0.4	GOOD	NO	WHITE		
TEST 128	DORMITORY	KITCHEN	CONCRETE CEILING		0.0		GOOD	NO	WHITE		
SCREEN 129	DORMITORY	DINING ROOM	WOOD DOOR CASING		0.3		GOOD	NO	DARK GREEN		
SCREEN 130	DORMITORY	DINING ROOM	WOOD DOOR			0.7	GOOD	NO	DARK GREEN		

ASSAY # EL VERDE	BUILDING	ROOM	SURFACE	XRF READING mg/cm²			SURFACE CONDITION	PAINT SAMPLE COLLECTED	COLOR	AA LAB RESULT	COMMENTS
				Positive	Negative	Inconclusive					
TEST 131	DORMITORY	DINING ROOM	WOOD DOOR		0.1		GOOD	NO	DARK GREEN		
SCREEN 132	DORMITORY	EXTERIOR PORCH	WOOD COLUMN			0.5	GOOD	NO	DARK GREEN		
SCREEN 133	DORMITORY	EXTERIOR PORCH	WOOD COLUMN		-0.3		GOOD	NO	DARK GREEN		

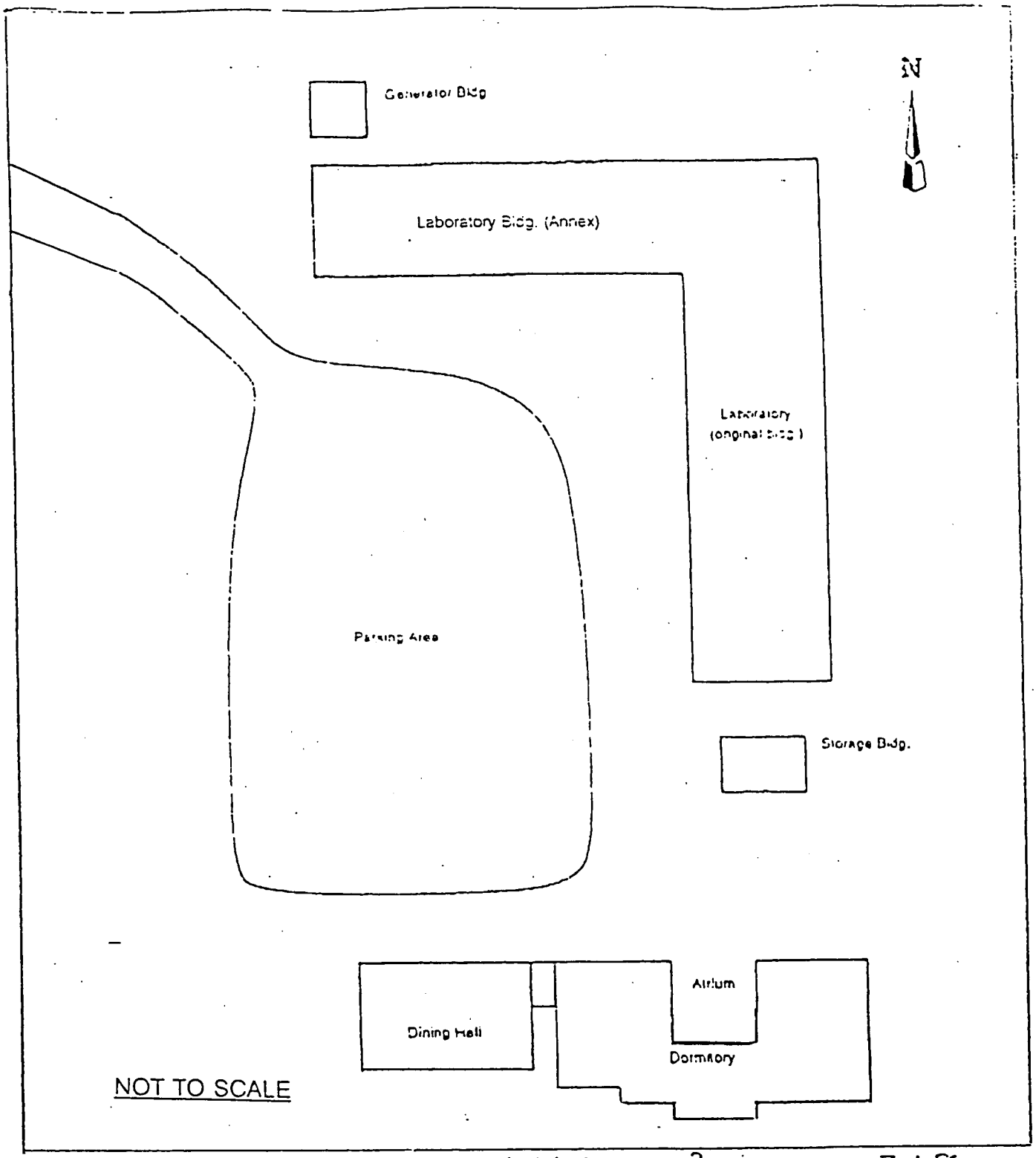


EL VERDE CEER FACILITY

Generator, Laboratory & Storage Bldg.

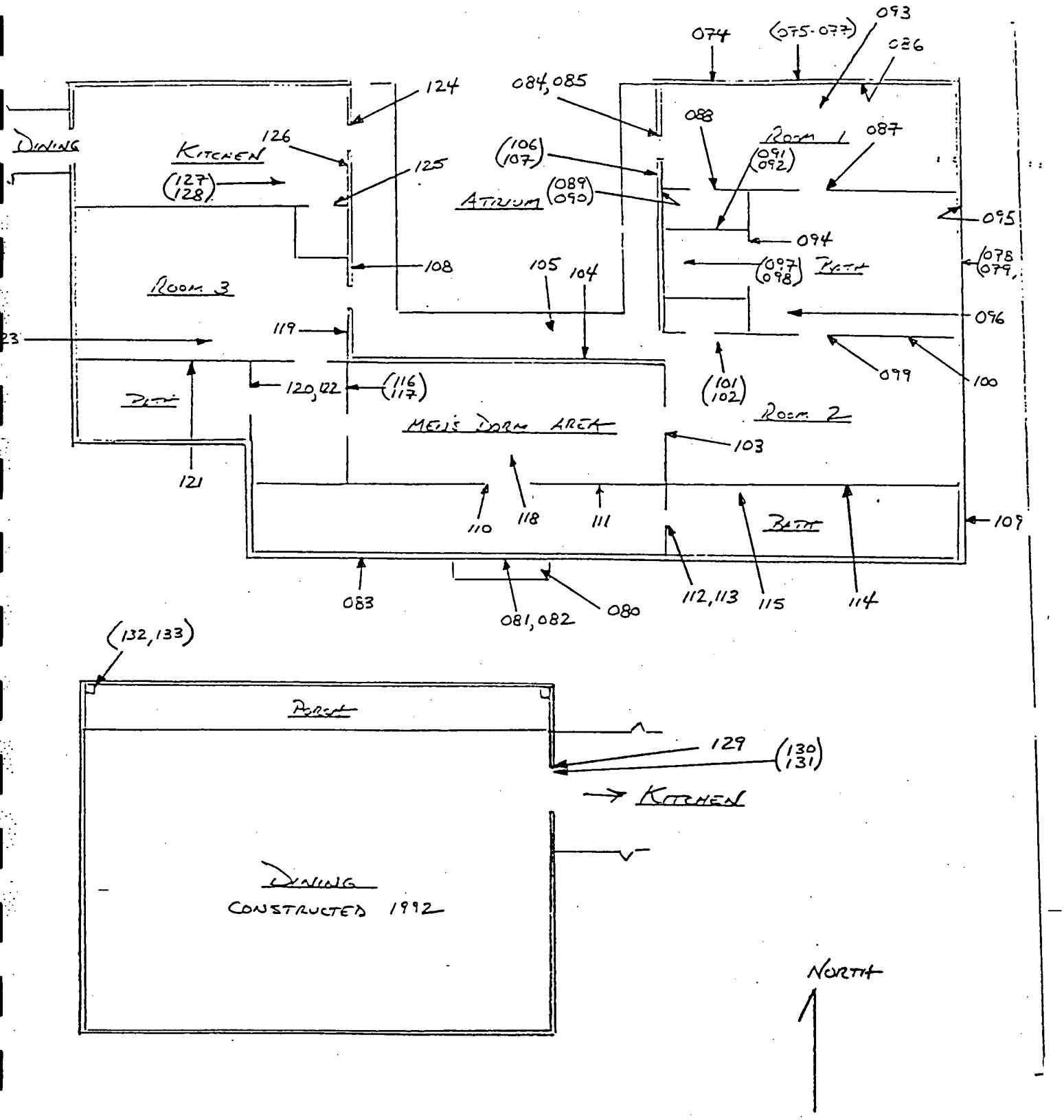
XRF Testing Locations/Sample Location Map

* TESTING PERFORMED ON 7-1-96



* All testing performed on 7-1-86

EL VERDE CEER FACILITY
SAN LORENZO, PUERTO RICO
SITE PLAN



EL VERDE CEER FACILITY

Dormitory & Dining Hall Bldg.

XRF Testing Locations/Sample Location Map

* Testing Performed on 7-1-96

SECTION V

ABATEMENT RESPONSE ACTIONS

RESPONSE ACTIONS

I. Hazard Abatement Strategies

A. Replacement - involves removing the components that have lead painted surfaces and installing new components that are free of lead containing paint. The following is a list of advantages and disadvantages offered by replacement:

Advantages

1. Permanent solution.

2. Allows for upgrade/may provide increased energy efficiency (eg. improved replacement windows).

3. No lead residue left behind on surfaces; therefore, post abatement criteria are easily met.

4. This method may integrate well with renovation/modernization projects.

Disadvantages

1. The cost of replacement may be high if done outside the context of large scale rehabilitation.

2. Replacement components may be of lower quality than the original components.

3. Some dust is generated during removal of components.

4. Adjacent surfaces may be damaged.

5. Reinstallation of certain components requires skilled carpentry.

6. A large volume of abatement debris may be generated.

7. Non-standard replacement parts may require special orders and additional ordering time.

8. May not be feasible for large surfaces - walls, ceilings, floors.

B. Encapsulation - involves making lead paint inaccessible by covering or sealing painted surfaces. The following is a list of advantages and disadvantages offered by encapsulation:

Advantages

1. Low dust if surface preparation is minimal.

2. May be faster than other methods, especially on large surfaces - walls, ceilings, floors.

3. Minimal abatement debris.

Disadvantages

1. May not provide long term protection - integrity of encapsulation materials may deteriorate over time.

2. Requires routine inspection.

3. May require routine maintenance.

4. Quality installation required for durability.

5. Installation may require skilled workers and may be expensive.

6. A new coat of paint or primer, paper wall coverings, or contact paper are unacceptable materials for encapsulation.

7. Not acceptable method of abatement for friction surfaces such as window sashes, door jambs, etc. as encapsulant will deteriorate at friction area.

C. Paint Removal - involves stripping the lead paint from the surfaces of components by chemical or mechanical means.

On-site Paint Removal

1. Does not require highly skilled labor.

2. Dry scraping generates large amounts of dust and may require more extensive worker protection methods, containment, and extra clean-up to achieve compliance with clearance standards.

3. Lead residue may remain on substrate and may be difficult to remove.

4. Chemical strippers may be flammable. They may require ventilation and may contain toxic substances. Caustic chemical strippers can cause skin and eye injuries if used improperly. The high pH of caustic strippers may require that they be treated as a hazardous waste regardless of the lead content.

5. Heat guns may pose a potential fire hazard if used improperly. Heat guns generate noxious organic vapors which are formed from the thermal decomposition of the paint film.

Off-site Paint Removal (A professional paint stripping operation)

1. The quality of the finished product is generally better than on-site removal.

2. There is a possibility of damage to components or adjacent surfaces.

3. Lead residue may remain on the substrate.

4. Possible swelling of some components which may make reinstallation difficult.

II. Applications

A. Replacement - applicable to most interior or exterior components. Also for components that are deteriorated, recommended for windows, doors, and easily removed building components. Not recommended for restoration projects when historic trust requirements apply.

B. Encapsulation - applicable to exterior trim, pipes, walls, and floors. Also for interior trim, pipes, walls, ceilings, and floors. Some substrates and substrate conditions are inappropriate for encapsulation. (e.g. impact surfaces, or hot surfaces).

GCI ENVIRONMENTAL ADVISORY, INC.

165 DARLING STREET
WILKES-BARRE, PA 18701

LEAD MATERIAL SAMPLE ANALYSIS

CLIENT: DAC, Inc.
342 Madison Avenue
New York, NY 10173

PROJECT: Department of Energy
El Verde Ceer Facility / Mayaguez Ceer Facility

ANALYST: J. Boler

SAMPLING DATE: July 1 - 3, 1996

COLLECTED BY: D. Linski

PROJECT #: P96-K486-01
PR96-G001

ANALYSIS DATE: July 9, 1996

REVIEWED BY: Ann M. Rutkowski

SAMPLE NUMBER	LAB ID #	SAMPLE LOCATION/DESCRIPTION	LEAD % BY WEIGHT LEAD mg/l	> 0.5% LIMIT
001	64-6423	El Verde Ceer Facility, dormitory bldg., exterior window vent PAINT CHIPS	3.01 103.52	YES

ELAP #10952 ELPAT #8524

COMMENTS: None
Analysis by Flame Atomic Absorption Spectrophotometry as per EPA SW - 846 Method 3050. mg/l = Milligram per liter. Milligrams/liter (mg/l) is equal to micrograms/milliliter (µg/ml). Minimum Detection Limit is 0.10 mg/l.

ATOMIC ABSORPTION SPECTROPHOTOMETRY

GCI Environmental Advisory, Inc. is an active participant in the American Industrial Hygiene Association (AIHA) sponsored Environmental Lead Proficiency Analytical Testing Program (ELPAT), Laboratory ID # 8524. GCI is accredited by the New York State - Department of Health's Environmental Laboratory Approval Program (ELAP), Laboratory ID # 10952, for paint chip analysis. GCI has developed and implemented an intra-laboratory Quality Assurance/Quality Control program to ensure accuracy and consistency of results.

ANALYTICAL METHODOLOGY

Air filter samples collected for lead abatement projects are prepared in accordance with the NIOSH Analytical Method 7082. Samples are analyzed for lead content by Atomic Absorption Spectrophotometry with results reported as a concentration in micrograms per cubic meter ($\mu g/m^3$) and milligrams per liter (mg/l). Sample blanks are reported as milligrams per liter (mg/l). Samples reported as "<" indicates a concentration less than the detection limit.

Material samples (soil, paint chips, and dust wipes) are prepared via the hot plate in accordance with the EPA Methodology SW-846, Method 3050, "Acid Digestion of Sediments, Sludge, and Soils". Samples are analyzed by utilizing EPA Methodology SW-846 Analytical Method 7420 for lead with results reported as a concentration of percent lead for paint chips, micrograms per square feet for dust wipes ($\mu g/ft^2$), milligrams per kilograms for soils (mg/kg) and milligrams per liter (mg/l). Samples reported as "<" indicates a concentration less than the detection limit.

SAMPLE ARCHIVING

Samples are retained for a period of thirty days, unless otherwise specified by client. After the thirty day period, the samples are disposed. Sample solutions are disposed after sample analysis and quality assurance has been completed.

DISCLAIMERS

* GCI assumes no responsibility for financial or health consequences for action or lack of action taken by our clients or their agents as a result of these analytical reports. GCI can only attest to the validity, accuracy and completeness of sample collection, which was performed by GCI personnel. GCI is neither responsible nor liable for information provided by the client.

* This data pertains to the sample(s) provided.

* This report must not be reproduced without the full approval of GCI.

Should you have any questions concerning the above, please contact GCI at (717) 823-9069.

REFERENCE DOCUMENTATION

PROJECT: El Verde Ceer Facility **INSPECTORS:** D. Linski/E. Myslowski

XRF SERIAL #: AS081

DATE: July 1, 1996

Pre-Calibration

REFERENCE NUMBER	XRF READING mg/cm²
001	1.3
002	1.0
003	1.3
004	1.1
005	0.8

AVERAGE READING FOR 7-1-96: 1.1 mg/cm²

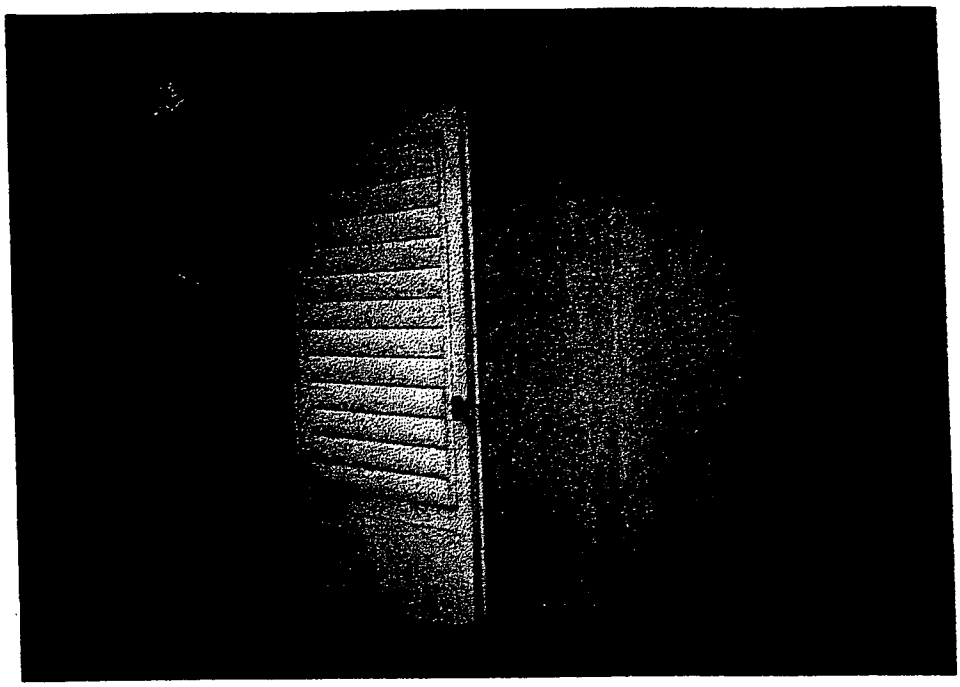
DATE: July 1, 1996

Post-Calibration

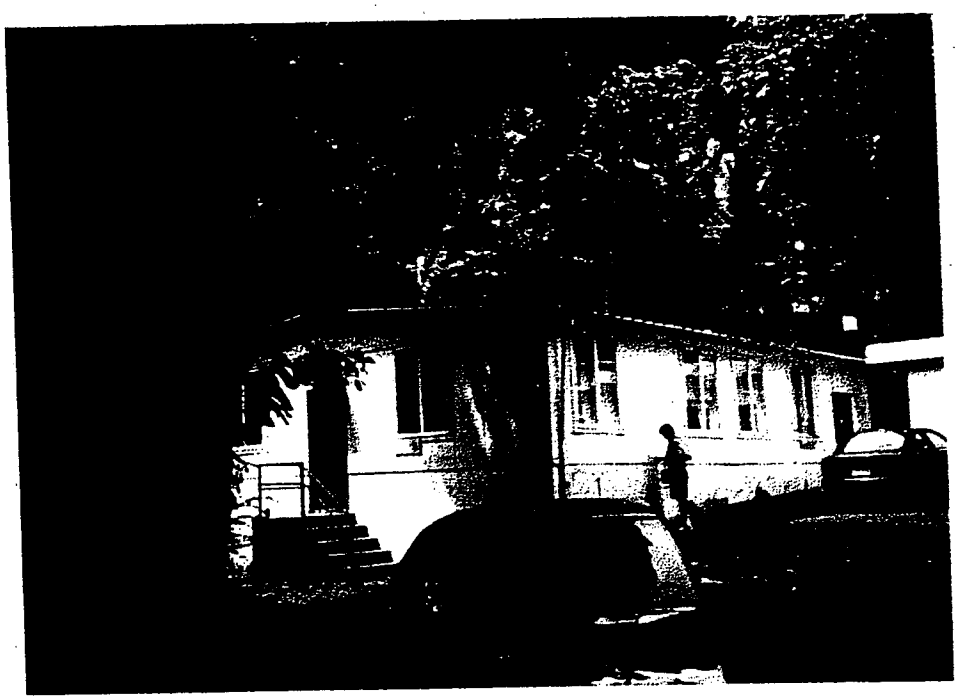
REFERENCE NUMBER	XRF READING mg/cm²
001	1.3
002	1.1
003	0.2
004	0.6
005	1.4

AVERAGE READING FOR 7-1-96: 0.9 mg/cm²

STANDARD: Scitec Calibration Block, 1.0 mg/cm²



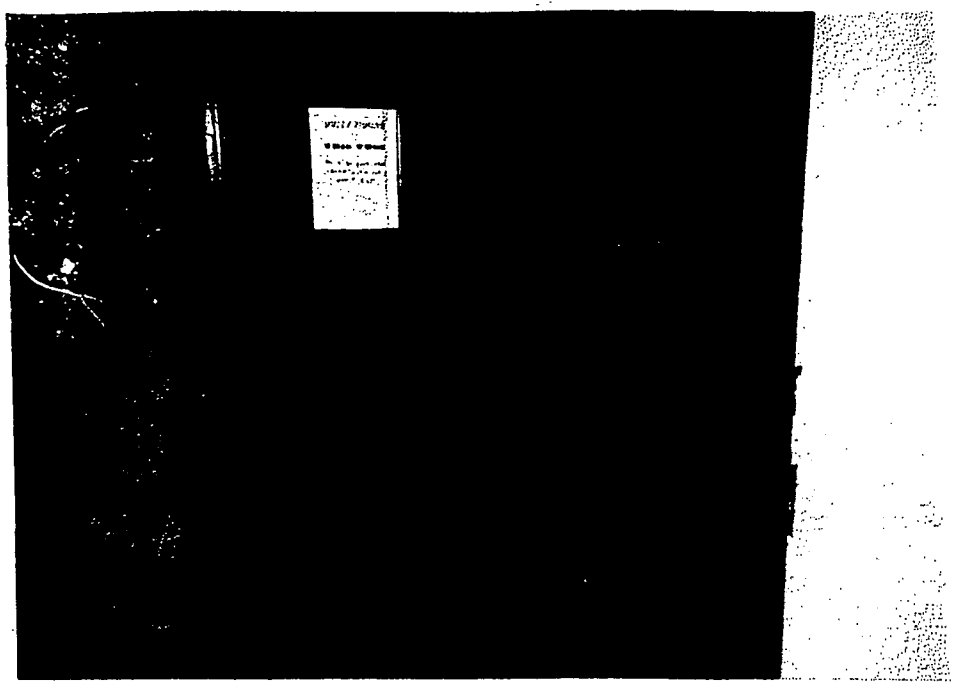
1. View of the Generator Building.



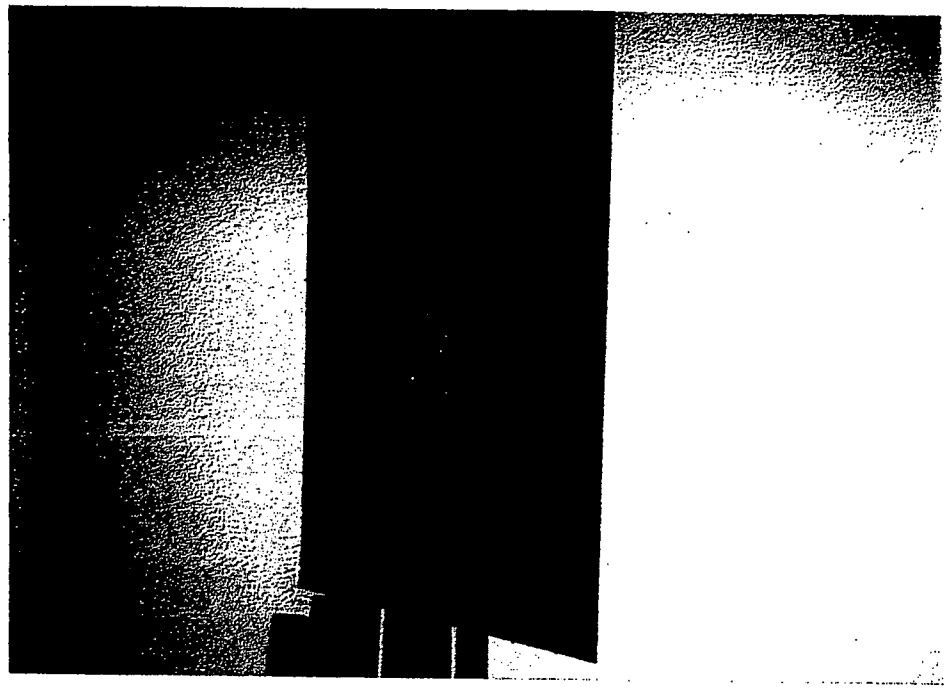
2. View of the Laboratory Annex Building.

3. View of the original Laboratory Building.

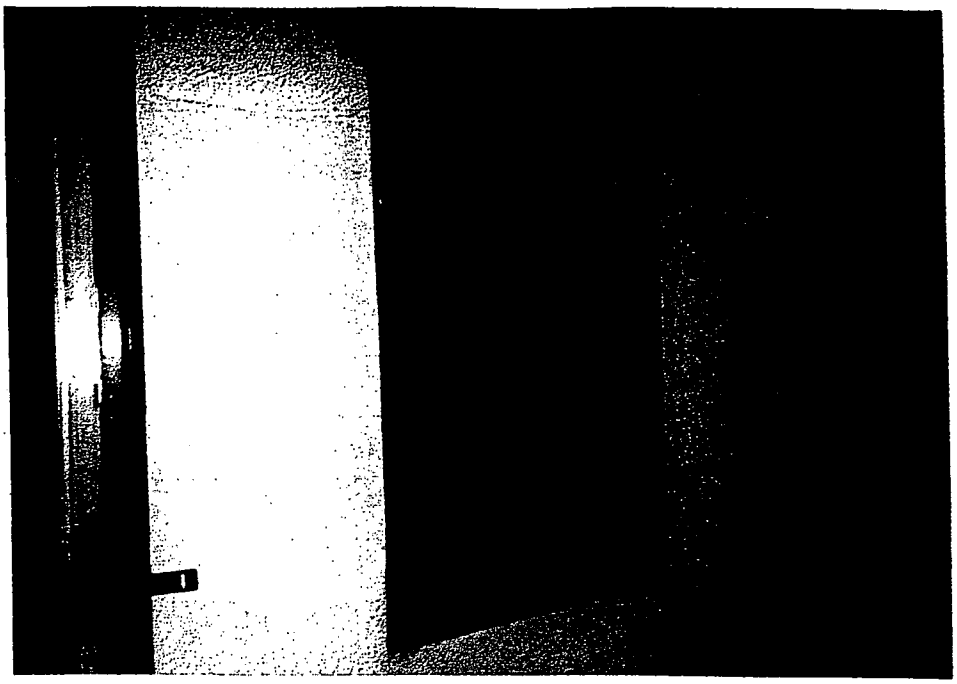
4. View of the Dormitory Building.



5. View of the wood doors associated with the Dormitory Building painted with lead-based paint.



6. View of the wood window shutters associated with the Dormitory Building painted with lead-based paint.



7. View of the metal window vents associated with the Dormitory Building painted with lead-based paint.

8. View of the Dining Hall Building.

Certificate of Training

RADIATION TRAINING PROGRAM

THIS IS TO CERTIFY THAT

EDWARD J. MYSLOWSKI

HAS SATISFACTORILY COMPLETED SCITEC CORPORATION'S WASHINGTON STATE APPROVED RADIATION TRAINING COURSE CONSISTING OF EIGHT CLASSROOM HOURS.

SCITEC CORPORATION

Instructor J. Hymers

Date January 28, 1992

Basic Safety and Operator Certification

No. 3143

This is to certify that

DANIEL C. LINSKI

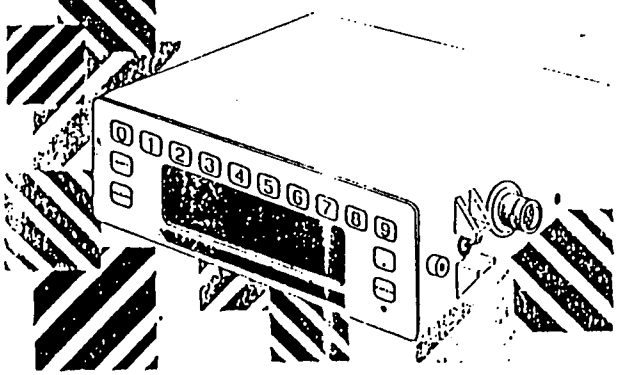
has satisfactorily completed SCITEC Corporation's Washington State approved Radiation Training Course consisting of eight classroom hours in:

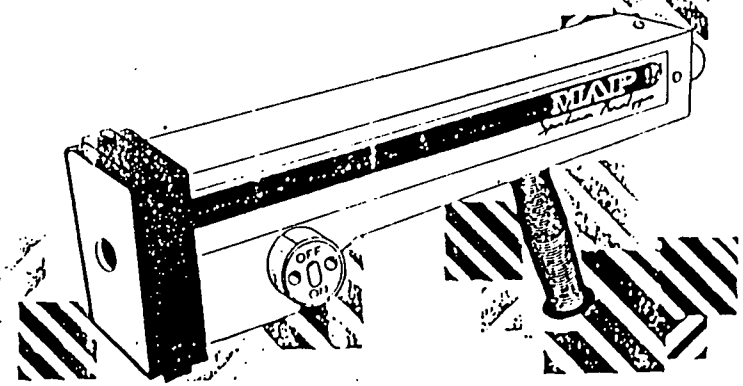
- Principles of XRF
- Fundamentals of Radiation
- Licensing Regulations
- Spectrum Analyzer type XRF operation
- Safe use of the Spectrum Analyzer
- Performance Characteristics

Instructor _____

Date November 4, 1993

SCITEC CORPORATION®





THE ENVIRONMENTAL

Training Center

210 N. Wayne Avenue, Suite 201 • Cincinnati, Ohio 45215 • 513-821-7772
Provider Number: 107

CERTIFIES THAT

DANIEL LINSKI
30 Delaware Street
Plains, PA 18705
SSN 205-54-7710

has successfully completed
The Ohio-APPROVED Lead Training COURSE for
INSPECTOR
and has passed the required examination in that discipline

Under civil and criminal penalties of law for the making or submission of false or fraudulent statements or representations (18 U.S.C. 1001 & 15 U.S.C. 2615), I certify that this training complies with the applicable requirements of Title IV of the "Toxic Substances Control Act", 40 CFR Part 745, and any other applicable Federal, State, or local requirements, as amended.

Course date 09/18/95-09/20/95
Issuance date 09/20/95
Certificate No. CR092095-06
Expires 09/19/97

Authorized Signature

Class Location: 210 N. Wayne Avenue
Cincinnati, OH 45215

THIS IS TO CERTIFY THAT

Daniel Linski

HAS MET THE LEAD PAINT SERVICES ACCREDITATION REQUIREMENTS FOR

Inspector Technician

EXPIRATION DATE 02/13/1998

TRAINING PROVIDER _____

William H Rahn 2/13/96

ADMINISTRATOR, LEAD PAINT ACCREDITATION
MARYLAND DEPARTMENT OF THE ENVIRONMENT

DATE

COURSE DATE 09/18/1995

STATE OF MARYLAND

Certificate # 184

TESTWELL CRAIG LABORATORIES, INC.

ENVIRONMENTAL EDUCATION DIVISION

This Continuing Education Diploma certifies that

Daniel C. Linski

has completed a 40 hour course during the period 2/7/94-3/18/94 *and has met the requirements for Certification as specified by the Westchester County Department of Health Lead Contractor Proficiency Program.*

CERTIFIED LEAD ABATEMENT CONTRACTOR

EPA/HUD Equivalent, NYS, WESTCHESTER COUNTY DEPARTMENT OF HEALTH Approved Training Program

Identification Number:
MP31894LEADWORK7

Exam Score: 91

Marco J. Pedone, PhD, MPH, CET, OHST
Training Director
TESTWELL CRAIG LABORATORIES, INC