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Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

FINAL REPORT ON THE REMEDIAL ACTION AT THE ACID/PUEBLO CANYON SITE

Los Alamos, New Mexico

Bechtel National, Inc.
Advanced Technology Division

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FINAL REPORT ON
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LOS ALAMOS, NEW MEXICO

OCTOBER 1984

Prepared for

UNITED STATES DEPARTMENT OF ENERGY
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By

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ABSTRACT

The Acid/Pueblo Canyon site (TA-45) was designated in 1976 for remedial action under the Formerly Utilized Sites Remedial Action Program (FUSRAP). During the period 1943-64 untreated and treated liquid wastes generated by nuclear weapons research activities at the Los Alamos Scientific Laboratory (LASL) were discharged into the two canyons. A survey of the site conducted by LASL in 1976-77 identified two areas where radiological contamination exceeded criteria levels. The selected remedial action was based on extensive radiological characterization and comprehensive engineering assessments and comprised the excavation and disposal of 390 yd^3 of contaminated soil and rock.

This document describes the background to the remedial action, the parties involved in administering and executing it, the chronology of the work, verification of the adequacy of the remedial action, and the cost incurred.

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ABBREVIATIONS

cm	centimeter
ft	foot
ft^3	cubic foot
gal	gallon
in.	inch
m	meter
m^2	square meter
µCi/cc	microcurie per cubic centimeter
µR/h	microroentgen per hour
mR	milliroentgen
mR/h	milliroentgen per hour
pCi/g	picocurie per gram
pCi/l	picocurie per liter
yd^3	cubic yard

1.0 INTRODUCTION

In 1974 the Atomic Energy Commission (AEC) initiated a survey program to identify and radiologically characterize all formerly utilized U.S. Army Corps of Engineers' Manhattan Engineer District (MED) and AEC sites involved with nuclear materials. With the establishment of the Department of Energy (DOE) in 1977, the responsibility for this survey program was assigned to the Assistant Secretary for the Environment (ASEV), who entitled it the Formerly Utilized Sites Remedial Action Program (FUSRAP). Since mid-1979 FUSRAP responsibilities have been shared variously by the ASEV and the Assistant Secretary for Energy Technology [now Assistant Secretary for Nuclear Energy (ASNE)]. Effective in 1982 all major responsibilities (site identification, radiological characterization, determination of the need for remedial action, implementation of the remedial action, including waste disposal or stabilization of residual material, and post remedial action certification) were consolidated and became the responsibility of ASNE.

Following identification of a site and determination of whether DOE has authority to undertake remedial action, radiological survey records are reviewed. If such data are lacking or incomplete, further surveys are conducted as necessary. The FUSRAP Project Management Contractor (PMC) and its subcontractors prepare a series of engineering studies and environmental reports for the site to evaluate remedial action alternatives. Documentation required by the National Environmental Policy Act (NEPA) as part of this evaluation is prepared by the Argonne National Laboratory (ANL). The action that is deemed appropriate by DOE based on the NEPA process evaluations is then implemented with consideration for public safety and in compliance with the Atomic Energy Act of 1954, as amended, and related Nuclear Regulatory Commission (NRC) or applicable federal, state, and local licensing requirements.

Remedial action at the Acid/Pueblo Canyon site was administered by DOE through its FUSRAP Lead Field Office, the Oak Ridge Operations (ORO) Office and FUSRAP PMC, Bechtel National, Inc. (BNI). The Los Alamos National (formerly Scientific) Laboratory (LANL) and DOE Los Alamos Area Office (LAAO) provided support to DOE-ORO and BNI.

2.0 SITE DESCRIPTION AND BACKGROUND

Acid and Pueblo Canyons are among numerous canyons cut into the Pajarito Plateau in northcentral New Mexico, approximately 100 km (60 mi) north-northeast of Albuquerque and 40 km (25 mi) northwest of Santa Fe. Acid Canyon is a small tributary near the head of Pueblo Canyon; it and Middle Pueblo Canyon lie within the townsite of Los Alamos (Figure 2-1). The remedial action site (TA-45) is accessible from Canyon Road, which runs just south of the former TA-45 Waste Treatment Plant as shown on Figure 2-1.

Presently both canyons are used for recreational activities. However, future residential and associated light commercial development is conceivable.

The site was designated a former MED/AEC site because untreated and treated liquid wastes generated by nuclear weapons research activities at the LANL during the period 1943-64 were discharged into the two canyons. From late 1943 until 1951 untreated liquid wastes were discharged. The effluents contained isotopes of strontium, cesium, uranium, plutonium, americium, and tritium. In 1951 a waste treatment plant (TA-45) at Acid Canyon became operational, discharging treated wastes into the canyon until 1964 at which time all wastes were diverted to a new plant (TA-50) located south of Los Alamos Canyon within the present LANL site.

The AEC began decontamination and decommissioning of the TA-45 plant and its associated vehicle decontamination facility in late 1966. Both facilities were demolished and the contaminated building materials, sewer pipe, and soil from the vehicle decontamination facility disposed of at the LASL radioactive waste disposal areas. Portions of the Acid Canyon cliff face were also decontaminated and some contaminated rock, soil, and sediment removed from the canyon floor. By July 1967 the areas around the TA-45 plant and in Acid Canyon were considered sufficiently free of contamination to permit release from federal government control (Reference 1).

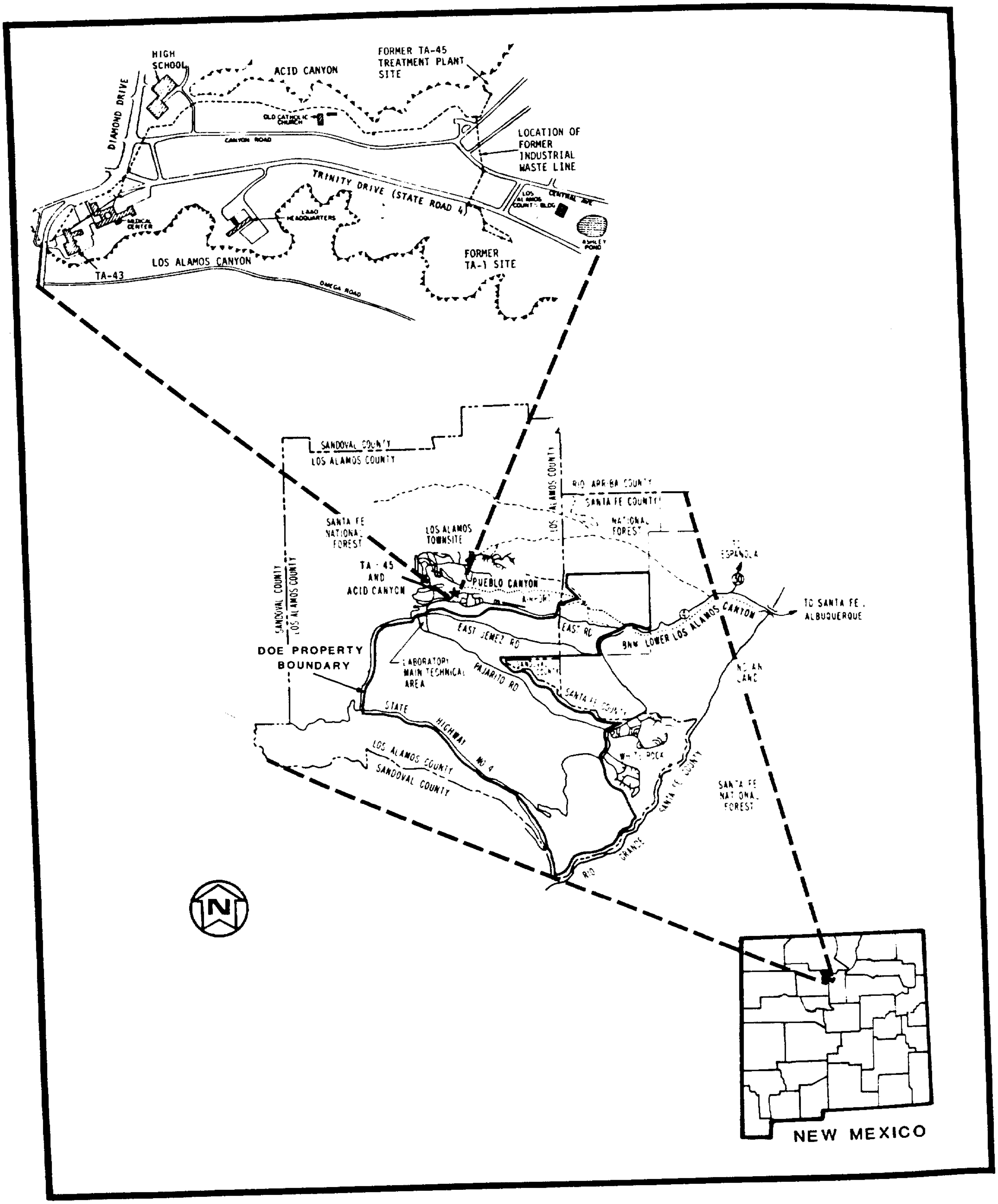

FIGURE 2-1 LOCATION OF ACID/PUEBLO CANYON SITE

On July 1, 1967 the AEC transferred to the County of Los Alamos ownership of the former TA-45 site, Acid Canyon, and the portion of Pueblo Canyon encompassing the channel from Acid Canyon eastward to a point approximately 1,190 m (3,900 ft) west of the Los Alamos-Santa Fe county line. The transfer was in accordance with the provisions of the Community Disposal Act, subject to the reservation of an easement for continued access to and maintenance of sampling locations and test wells in and adjacent to the channel in Acid and Pueblo Canyons.

Low-level residual contamination in the channels was monitored periodically as part of routine environmental surveillance conducted by LASL. In 1976 the Acid/Pueblo Canyon site was identified as warranting reevaluation with modern instrumentation and analytical methods to determine whether further corrective measures were required. LANL undertook the resurvey in 1976-77; its final report was issued in 1981 (Reference 1). This and a supplemental survey conducted in 1980 by Ford, Bacon and Davis, Utah (FBDU) indicated that contamination in the areas of the former untreated waste effluent outfall and former vehicle decontamination facility exceeded the cleanup criteria levels specified in Subsection 4.1 of this document.

BNI performed an engineering evaluation of the site based on the LANL and FBDU data. In this study BNI presented three remedial action scenarios: no action, minimal action, and decontamination and disposal (Reference 2). LANL prepared the associated environmental analysis report (Reference 3) and ANL prepared the required NEPA analysis documentation (Reference 4). Decontamination and restoration was approved by DOE; BNI, as FUSRAP PMC, was assigned the responsibility for implementation.

3.0 FUSRAP ORGANIZATION FOR THE ACID/PUEBLO CANYON REMEDIAL ACTION

3.1 ADMINISTRATIVE ORGANIZATION

Remedial action at the Acid/Pueblo Canyon site was administered by the Technical Services Division of DOE-ORO. BNI, as FUSRAP PMC, planned, managed, and implemented the work for DOE-ORO, beginning in early 1981.

BNI selected Professional Land Surveying (PLS) of Santa Fe, NM, and the Zia Company of Los Alamos, New Mexico to implement the remedial action. BNI was also responsible for radiological monitoring of site personnel and activities. Monitoring was performed by its radiological support subcontractor, Eberline Instrument Corporation (EIC) of Albuquerque, New Mexico. EIC supports BNI in this role at all FUSRAP sites.

Argonne National Laboratory (ANL) is the contractor responsible to DOE-ORO for the NEPA process for all FUSRAP sites, including the Acid/Pueblo Canyon site.

The DOE-LAAO facilitated contacts among BNI, LANL, the Zia Company, local officials, and the media during preparation for and conduct of remedial action. LANL supplied EIC with protective clothing required in the conduct of the health physics program (dust masks, shoe covers, gloves, etc.); members of its Environmental Surveillance Group conferred with and advised BNI, EIC, PLS, and Zia during remedial action and provided oversight support. Use of the LANL Radioactive Waste Disposal Area G (TA-54) was arranged between DOE-ORO and LANL, using Zia for transportation of the wastes.

3.2 FIELD ORGANIZATION

The site organization consisted of a BNI Site Superintendent who directed the activities of site representatives from PLS (civil survey), the Zia Company (excavation and transportation services), and EIC (radiological control and health physics). The BNI Site Superintendent also acted as liaison with the representatives of DOE-ORO, DOE-LAAO, and LANL.

The PLS team consisted of a party chief/instrument man and a rodman. The Zia Company team consisted of a site engineer and working foremen of the crafts in the work crews (operating engineers, drivers, carpenters, iron workers, and laborers). An average of eight Zia personnel worked on the site each day. EIC personnel comprised two health physics technicians.

4.0 REMEDIAL ACTION

4.1 APPLICABLE CRITERIA

Remedial action criteria applicable to the Acid/Pueblo Canyon site were the external exposure rates specified by 40 CFR 192 (Reference 5) and the radionuclide concentrations in soil listed in Table 4-1 (References 2, 7, and 8). The radiation exposure rate criterion was based on the annual limit for population exposures of 170 mR. For control purposes, an exposure rate of 0.02 mR/h (20 µR/h) above background was used. Background exposure rates in the Los Alamos area are 9.4-17.4 µR/h. Soil criteria for two separate pathways, food cultivation/ingestion and resuspension/inhalation, were considered. The former is the more restrictive pathway and provides the most conservative criteria against which to evaluate the adequacy of remedial action. However, the latter was the more realistic basis for evaluation in the case of Acid/Pueblo Canyon since the terrain on and near the remedial action site is unsuitable for cultivation.

4.2 SITE CHARACTERIZATION

The areas in Acid Canyon requiring remedial action were defined by the radiological survey conducted by LANL in 1976-77. LANL reviewed records of the treatment plant and data on types and amounts of contaminants discharged, environmental monitoring and hydrogeologic studies, and special radioecology research studies. These data were compiled to provide points of comparison and a basis for planning the acquisition of new data, most of which consisted of multiple analyses of several hundred sediment and soil samples for the radionuclides listed in Table 4-1. Additional data on concentrations of these contaminants in air were obtained and gamma surveys performed.

As shown in Figure 4-1, four areas were contaminated in excess of background concentrations. However, only the two designated as having elevated surface activity were contaminated in excess of the

TABLE 4-1

SOIL CLEANUP CRITERIA FOR REMEDIAL ACTION
AT ACID/PUEBLO CANYON*

Radionuclide	Criteria (pCi/g) Food Cultivation/ Ingestion	Resuspension/ Inhalation
Strontium-90	100	2×10^6
Cesium-137	80	7×10^6
Plutonium-238	100	7600
Plutonium-239	100	7600
Americium-241	20	---
Uranium (natural)	40**	2200
Radium-226	5**	7000

*Criteria are applied as average concentration per 100 m^2 areas.

**After extensive health effects studies, the limit for uranium (natural) was increased to 75 pCi/g in November 1983 (Reference 9). Based on these and other studies, the limit for radium-226 was also modified in November 1983 to provide for 5 pCi/g in the first 15-cm soil layer and 15 pCi/g in successively deeper 15-cm layers (Reference 9).

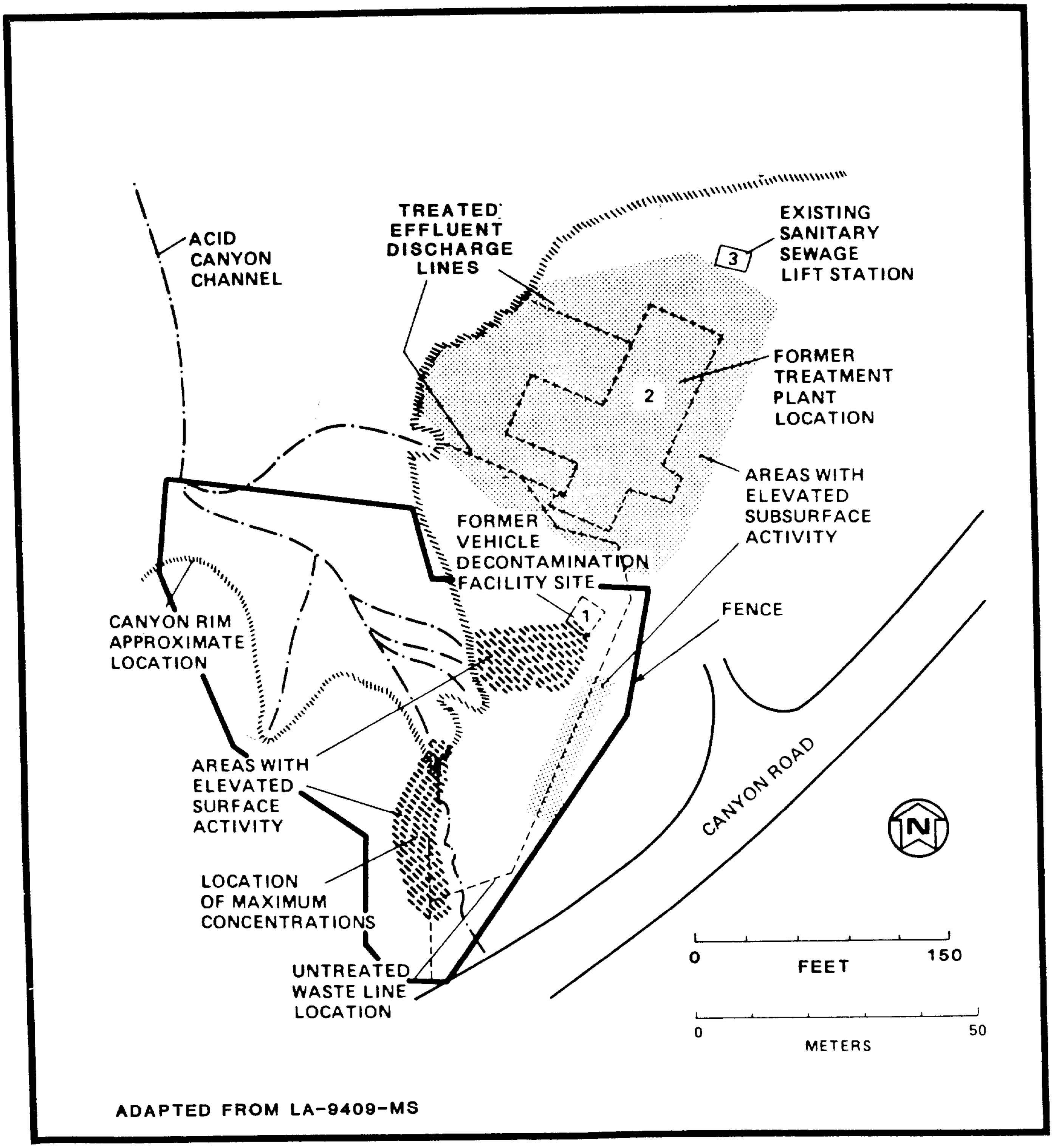

FIGURE 4-1 AREAS OF RESIDUAL RADIOACTIVITY AT ACID CANYON

criteria presented in Table 4-1. The LANL radiological survey data for these two areas are presented in Table 4-2 and Figure 4-2. The placement of individual data points was accomplished by extrapolating from small ungridded LANL drawings; therefore, accuracy of placement on Figure 4-2 is ± 1.5 m (5 ft).

Soil sampling was undertaken in 1980 by FBDU to supplement the LASL data and to verify expected background radionuclide concentrations in the Acid Canyon area. Results confirmed the LASL designation of remedial action areas.

4.3 PREPARATIONS FOR REMEDIAL ACTION IMPLEMENTATION

The decontamination and restoration scenario approved by DOE specified that the location of the two general areas requiring decontamination would be reestablished using coordinates from previous LASL surveys, a section of the chain-link fence enclosing upper Acid Canyon would be removed to permit access for remedial action, a barrier would be erected across the upper canyon to prevent loss of excavated material, and 30 to 45 cm (12 to 18 in.) of soil and volcanic tuff would be removed and disposed of at the LANL Radioactive Waste Disposal Area G (TA-54). Field measurements made before and during excavation would determine whether further excavation was required to meet criteria levels. The excavated and disturbed areas would be left to stabilize and revegetate naturally.

BNI engineers prepared drawings, specifications, and other subcontract documents preparatory to the issuance of civil survey and excavation subcontracts. A civil survey subcontract package was issued for bids on June 17, 1982. Bids were solicited from firms local to Los Alamos. Three bids were received and evaluated; the subcontract was awarded to PLS on July 28, 1982.

TABLE 4-2

ACID CANYON PRE-REMEDIAL ACTION

RADIOLOGICAL SURVEY DATA

COORDINATES[1]		pCi/g				
X	Y	Plutonium 239	Plutonium 238	Americium 241	Cesium 137	Strontium 90
25	35	38.0	0.3	N/A	78.0	183.0
27	17	0.6	0.0	N/A	1.8	1.5
30	10	34.0	0.3	N/A	0.3	0.6
30	30	42.0	0.3	N/A	176.0	229.0
35	30[2]	5.8	0.3	4.0	2.9	N/A
45	60[2]	0.5	0.1	3.0	39.0	N/A
40	30[2]	200.0	1.8	32.0	47.0	N/A
45	80[2]	1.0	0.1	1.0	2.4	N/A
50	0	4.0	0.1	N/A	1.0	1.1
50	45[2]	20.0	0.2	4.0	153.0	N/A
100	0	0.3	0.01	N/A	0.3	0.4
133	68	86,900.0	326.0	55.0	10.7	1.0
136	62	163,000.0	696.0	1,200.0	1.1	0.9
139	0	0.2	0.0	N/A	1.8	2.6
139	72	3690.0	26.4	106.0	36.0	5.1
140	65	433.0	2.7	10.0	25.1	1.8
141	57	16,300.0	70.4	126.0	2.3	2.4
145	67	61.0	0.08	1.5	2.2	0.5
146	57	64.0	0.26	0.9	1.9	0.9
157	0	0.2	0.01	N/A	0.7	0.5
157	48	259.0	1.1	N/A	0.1	0.2
172	33	44.0	0.3	N/A	0.3	0.5
187	20	12.0	0.1	N/A	2.2	2.9

(1) Based on extrapolation of data presented in DOE/EV-0005/30

(2) Data collected by BNI

N/A Not analyzed

Source: LANL (Reference 1)

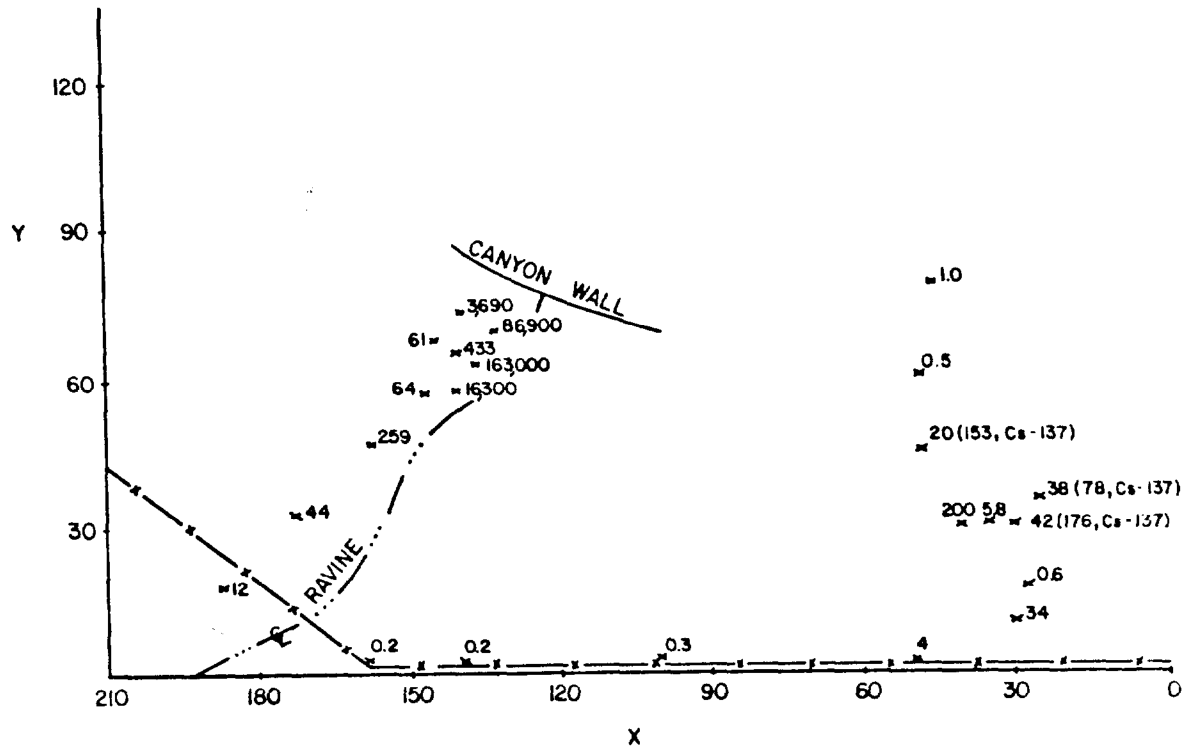

FIGURE 4-2 PRE-REMEDIAL ACTION PLUTONIUM-239 CONCENTRATION IN SOIL IN pCi/g (CESIUM-137 INCLUDED TO INDICATE MIXED FISSION PRODUCT CONTAMINATION)

A Memorandum Purchase Order for the excavation and transportation of the contaminated material was issued on July 22, 1982 to the Zia Company. As the prime construction contractor for LAAO, Zia already had the required clearances to operate on the LANL disposal area and experience with radioactive decontamination.

4.4 CHRONOLOGY OF REMEDIAL ACTION

On August 2, 1982 part of the chain-link fence enclosing Acid Canyon was removed to permit access to the remedial action areas, the debris/sediment barrier was installed, and the erection of a vehicle decontamination pad was begun (Figure 4-3). The following day the pad was completed and the site survey grid was tied to the New Mexico State Plane System and the LANL survey grid. PLS established a 4.6 m x 4.6 m (15 ft x 15 ft) grid over the remedial action area so that pre-remedial action contours could be recorded for subsequent comparison with post-remedial action contours to determine the volume of material removed.

Excavation commenced on August 4 in the area where the untreated effluent discharge line had been located. Contaminated material was excavated in 15 to 20 cm (6 to 8 in.) lifts by a backhoe and loaded directly into 18-yd^3 capacity dump trucks lined with reinforced plastic. Excavation was started at the point farthest from the loading point so that contaminated material was not moved over non-contaminated areas. When it was necessary to load over a non-contaminated area, that area was covered with plastic, which was rolled up and disposed of at the end of the operation. A water truck was maintained at the site during excavation so that the excavation area could be wetted to control dust. Hot spot excavation at the former vehicle decontaminations facility was performed manually with spades and shovels. Contaminated earth was loaded into 55-gal drums that were hoisted into dump trucks by an 18-ton hydraulic crane. All contaminated materials were disposed of at the LANL Radioactive Waste Disposal Area G (TA-54).

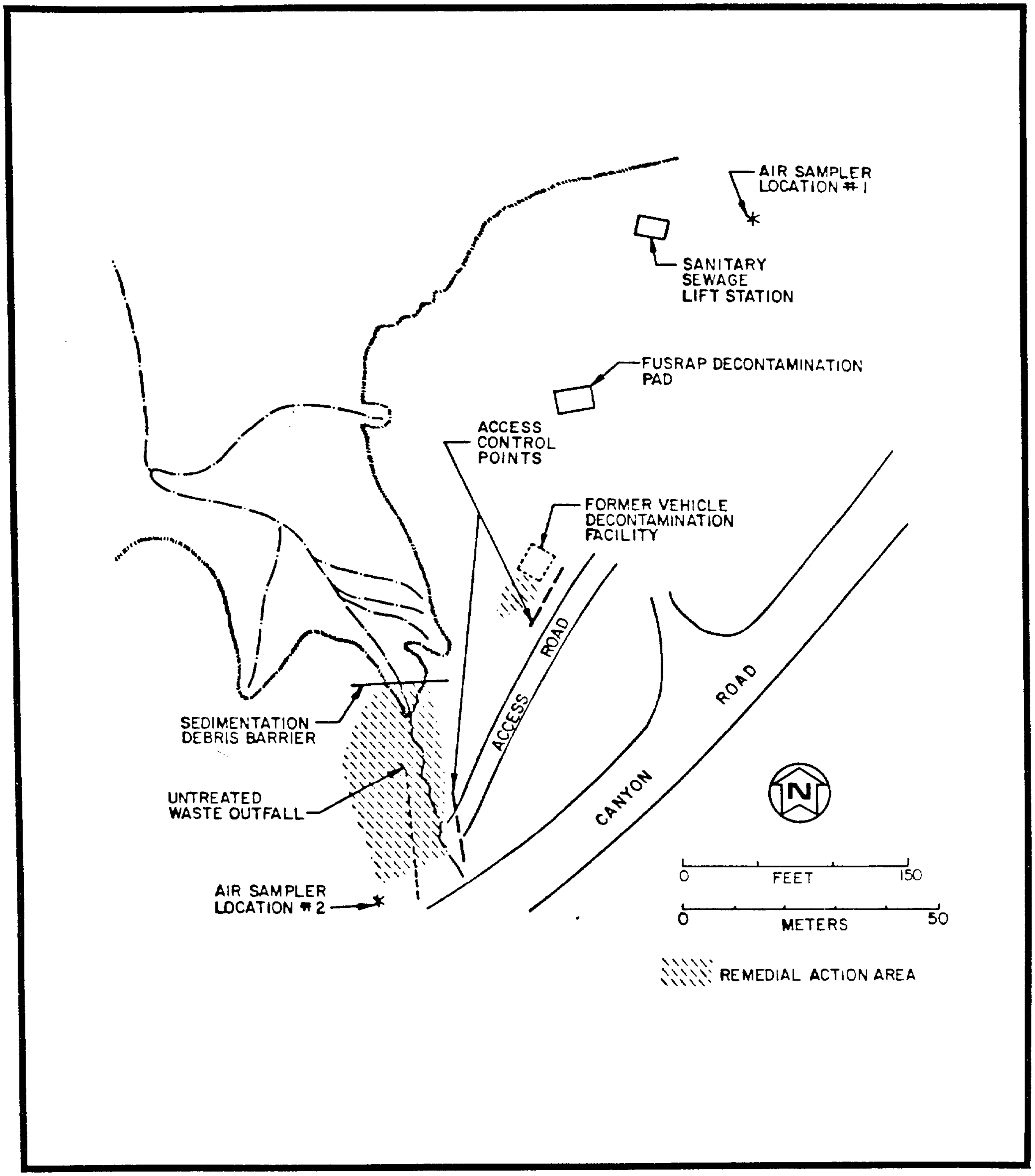

FIGURE 4-3 MAP OF UPPER ACID CANYON SITE DURING REMEDIAL ACTION

Following excavation EIC took radiological readings and soil samples for laboratory analysis to confirm satisfactory cleanup. While awaiting the results of this analysis, the fence was restored and equipment checked for contamination prior to release from the site. All equipment was found to be non-contaminated. The temporary decontamination pad remained in place; its drainage system was filled in and the debris/sediment barrier was removed from the canyon rim.

Laboratory results indicated that two spots of contamination remained in the untreated waste outfall area. These were excavated and disposed of on August 13 and EIC resurveyed and resampled the areas. The site was closed while awaiting laboratory results of the resampling, although arrangements were made for additional excavation if necessary. Sample analysis indicated that further excavation was required in the untreated waste outfall area. Final excavation was performed from September 27 to September 30, 1982. A total of 390 yd^3 of contaminated material was excavated in implementing the remedial action.

Backfilling the excavated area was impractical since the material removed was primarily sandstone and tuff. Backfill material placed on the site would have been highly susceptible to erosion.

After excavation activities were completed the site grid was reestablished for the final radiological survey to verify compliance with criteria for unrestricted release. Verification of compliance is discussed in greater detail in subsection 5.6.

The above work was conducted in accordance with accepted practices and in compliance with the Zia Company safety policies, the BNI FUSRAP Health and Safety Program, FUSRAP Radiological Protection Program, and BNI Nuclear Fuels Operation Quality Assurance Program as amended for FUSRAP (References 10, 11, and 12).

5.0 RADIOLOGICAL SUPPORT

Support of remedial action by the BNI/EIC health physics staff included access control, personnel training, personnel radiation exposure monitoring, and environmental monitoring. In addition, they established excavation limits in the field following analysis of data from the 1976-77 LANL radiological survey, performed surveys during excavation to determine the effectiveness of the remedial action, and conducted post-remedial action surveys to confirm that decontamination criteria were met.

5.1 ACCESS CONTROL

Access to the area was controlled through a point of entry located at the southeast corner of the untreated waste discharge area as shown in Figure 4-3. All personnel entering the controlled area (hatched sections of Figure 4-3) were issued shoe covers and gloves. When activities created a high potential for generating dust all workers were issued dust masks.

When leaving the controlled area all personnel were monitored for contamination. Vehicles were similarly monitored. A decontamination pad wash down area was provided for vehicles. However, during the remedial action activities all vehicles were found to be non-contaminated. Controlled vehicle/material logs were maintained throughout remedial action operations and are now on file at the BNI office in Oak Ridge, Tennessee.

5.2 PERSONNEL TRAINING

A radiological safety orientation program was presented to all personnel involved with construction and excavation activities prior to their beginning work. Emphasis was placed on the need for personal protection, contamination control, and monitoring procedures. All training was documented by signed statements from each attendee acknowledging his understanding of the material presented. These statements and a list of references and training aids used in the orientation are on file at the BNI Oak Ridge office.

5.3 PERSONNEL MONITORING

Radiological monitoring of personnel involved in remedial action was conducted to ensure compliance with protection standards. Personnel were monitored by means of bioassay, dosimetry, and lapel air samplers.

5.3.1 Bioassay

Urine specimens were collected from Bechtel and PLS onsite personnel prior to beginning work and prior to their termination from the job. Specimens were shipped to the EIC Albuquerque laboratory for plutonium-239, cesium-137, and mixed fission products analyses.

Personnel employed by the Zia Company were on a bioassay program as part of their routine job functions at Los Alamos and were, therefore, not included in the FUSRAP bioassay program.

All results from the FUSRAP bioassay program for the remedial action at Acid/Pueblo Canyon were below detectable limits. The detection limit for plutonium-239 is 0.1 pCi/l, for cesium-137 is 30 pCi/l, and for fission products is 15 pCi/l.

5.3.2 Dosimetry

Workers who did not already have an assigned radiation monitoring badge were issued a thermoluminescent dosimeter (TLD) badge. TLD badges were issued prior to the beginning of work and collected upon termination of the job. Results showed that no workers were exposed to gamma radiation levels distinguishable from natural background. All TLD exposure records are on file at the BNI Oak Ridge office.

5.3.3 Lapel Air Samplers

Personnel operating heavy equipment within the remedial action area wore lapel air samplers during all excavation. All results of lapel air samples were less than detectable quantities. Detection limits are less than 25 percent of the applicable concentration guide for controlled areas per DOE Order 5480.1A, Chapter XI (Reference 11).

5.4 ENVIRONMENTAL MONITORING

The radiological safety program also provided air quality surveillance. During initial excavation two continuous air samplers were deployed. As shown in Figure 4-3, one was positioned near the access control point to determine pre-excavation radiation levels and one was northeast of the decontamination pad. These samplers were run intermittently for four days. Composite samples of filters for each unit were analyzed for plutonium-238 and -239, americium-241, cesium-137, strontium-90, and isotopic uranium. All results were less than 1×10^{-13} µCi/cc. During the final excavation only the location near the access control point was monitored. Analysis for gross alpha contamination indicated that all results were less than 1×10^{-13} µCi/cc. These results are less than 10 percent of the most restrictive concentration guides for controlled areas per DOE Order 5480.1A, Chapter XI, 2×10^{-12} µCi/cc for alpha emitters (plutonium-239) and 1×10^{-9} µCi/cc for beta emitters (strontium-90).

5.5 IN SITU SURVEYS TO ESTABLISH EXCAVATION LIMITS

Excavation limits that had been defined from survey data collected by LANL were verified or modified as required. Survey techniques included surface gamma measurements, near-surface gamma measurements, and surface beta-gamma measurements as described below. The same techniques were used to detect hot spots and to determine post-remedial action compliance with release criteria.

5.5.1 Near-Surface Gamma Measurements

Near-surface gamma measurements were made on a 1.5-m x 1.5-m (5-ft x 5-ft) grid using a 5 cm x 5 cm detector (Eberline Model SPA-3) coupled to a rate meter/scaler (Eberline Model PRS-1). Measurements were made at a height of 1 m (3 ft) above the ground surface. The system was calibrated in µR/h.

5.5.2 Surface Gamma Measurements

Surface gamma measurements were made on a 1.5-m x 1.5-m (5-ft x 5-ft) grid using a 5 cm x 0.2 cm NaI detector (Eberline Model PG-2) coupled to a rate meter/scaler (Eberline Model PRS-1). Measurements with the PG-2 were made at approximately 2-3 cm (1 in.) above the ground surface.

5.5.3 Surface Beta-Gamma Measurements

Surface beta-gamma measurements were made on a 1.5-m x 1.5-m (5-ft x 5-ft) grid using a pancake geometry Geiger Mueller probe (Eberline Model HP-210) coupled to a rate meter/scaler (Eberline Model PRS-1). Measurements using the HP-210 were made approximately 1 cm (0.5 in.) above the ground surface.

5.6 DETERMINATION OF COMPLIANCE

Following excavation soil samples were collected on a 1.5-m x 1.5-m (5 ft x 5 ft) grid over the remedial action areas. Samples were collected to a depth of 5 cm (2 in.) where soil was available. Much of the area was barren sandstone or tuff following the excavation of the contaminated overburden. At points where soil was not present, the upper 5 cm (2 in.) of tuff was chipped from the surface to form the sample.

Samples were pre-treated prior to analysis by drying, crushing, and thoroughly blending. Pre-treated samples were analyzed by gamma scanning using a germanium detector or prepared using wet chemistry techniques for determination of concentrations of alpha- or beta-emitting radionuclides. By the nature of the waste streams constituting the source of the contaminants, plutonium-239 was the most prevalent radionuclide and was used as the controlling radionuclide for analysis of verification samples collected in the untreated waste outfall area. At the vehicle decontamination facility, cesium-137 and strontium-90 were the most prevalent radionuclides and were used as the controls for verification sample analysis.

For plutonium analyses, the pre-treated sample was aliquotted and the plutonium was leached from the aliquot. The plutonium recovered was electroplated on a metal counting planchet and the plutonium-238 and plutonium-239/240 activities were determined by alpha spectrographic analysis. The total efficiency of the process was determined through use of a tracer.

Determination of americium-241 utilized a similar methodology that was specific to americium rather than plutonium. Analysis of the sample for americium-241 utilized alpha spectrographic analysis.

Determination of strontium-90 concentration in the sample utilized the yttrium ingrowth technique. As with plutonium the sample was aliquotted, leached, and electroplated on a metal counting planchet prior to analysis.

Compliance with remedial action criteria listed in Table 4-1 was determined by the above analyses of soil samples and measurements of near-surface gamma radiation.

Verification was based primarily on the soil sample analyses due to the types of radiation emitted by the radionuclides of interest (alpha, beta, and low energy gamma-rays). External exposure rates were measured to complement soil sample analyses for the few gamma emitters that were present, cesium-137 and radium-226 and its daughters.

While in situ measurements were made during all phases of the remedial action (surface gamma and surface beta-gamma measurements) to guide excavation, they were of little or no use in determining compliance and were not included as part of this summary of the data.

5.7 POST-REMEDIAL ACTION STATUS

The migration route of the waterborne contamination and the 1976-77 LANL survey indicated that no contamination above criteria existed east of the ravine into which the untreated waste flowed. There is a clear line between contaminated and uncontaminated soil denoted by the east bank of the ravine. Therefore, samples for verification of the adequacy of the remedial action were collected within the area that was bounded on the east by the east bank of the ravine.

Within the untreated waste outfall area, the remedial action covered an area of approximately 100 m^2 (1,000 ft^2); therefore, data were averaged over the remedial action area to determine compliance with criteria. Post-remedial action sample data are presented in Table 5-1 and on Figure 5-1. The average concentration in soil in the remedial action area was 36 pCi/g plutonium-239. The maximum measured soil concentration was 370 pCi/g plutonium-239. A total of five samples within a small area in the ravine exceeded the criterion for plutonium-239 based on the more stringent food cultivation/ingestion pathway. In this area the average concentration of plutonium contamination was 226 pCi/g. Utilizing the more appropriate resuspension/inhalation pathway, all soil sample data were less than 5 percent of the criterion (7600 pCi/g). In view of the small size of this area relative to the site as a whole and the average concentration of plutonium-239 in the entire remedial action area, it was concluded that no additional remedial action was warranted based on plutonium-239 concentrations.

Plutonium-238 concentrations over the remedial action area were insignificant at less than 2 pCi/g or less than 2 percent of the food cultivation/ingestion pathway criterion for plutonium-238 (100 pCi/g).

TABLE 5-1

ACID CANYON POST-REMEDIAL ACTION

SOIL SAMPLE DATA

COORDINATES		pCi/g				
X	Y	Plutonium 239	Plutonium 238	Americium 241	Cesium 137	Strontium 90
40	35	N/A	N/A	5.4±0.5	8.5±0.9	N/A
60	30	N/A	N/A	0.4±0.1	1.2±0.1	N/A
123	63	140±10	0.7±0.6	N/A	N/A	N/A
125	60	200±10	2±1	N/A	N/A	N/A
125	65	230±10	1.2±0.6	N/A	N/A	N/A
125	70	1.9±0.6	0.3±0.3	N/A	N/A	N/A
130	50	18±2	0.2±0.3	N/A	N/A	N/A
130	55	82±3	0.5±0.2	N/A	N/A	N/A
130	60	77±4	0.2±0.3	N/A	N/A	N/A
130	65	190±30	0.5±0.5	N/A	N/A	N/A
130	70	370±10	1.4±0.6	N/A	N/A	N/A
135	45	2±1	0.1±0.1	N/A	N/A	N/A
135	50	11±2	0.1±0.3	N/A	N/A	N/A
135	55	31±3	0.2±0.3	N/A	N/A	N/A
135	60	7±1	0.2±0.4	N/A	N/A	N/A
135	65	2±1	0.1±0.2	N/A	N/A	N/A
135	70	4±1	0.0±0.1	N/A	N/A	N/A
140	45	2±1	0.0±0.3	N/A	N/A	N/A
140	50	6±1	0.1±0.2	N/A	N/A	N/A
140	55	21±3	0.2±0.3	N/A	N/A	N/A

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TABLE 5-1
(continued)

COORDINATES		pCi/g				
X	Y	Plutonium 239	Plutonium 238	Americium 241	Cesium 137	Strontium 90
140	60	17±2	0.4±0.3	N/A	N/A	N/A
140	65	0.4±0.3	0.1±0.1	N/A	N/A	N/A
140	70	0.3±0.3	0.0±0.1	N/A	N/A	N/A
145	50	11±1	<0.1	N/A	N/A	N/A
145	55	6±1	0.5±0.5	N/A	N/A	N/A
145	60	7±1	0.1±0.1	N/A	N/A	N/A
145	65	5±1	0.4±0.4	N/A	N/A	N/A
145	70	2.4±0.4	0.1±0.1	N/A	N/A	N/A
150	45	40±2	0.8±0.3	<1	<1	<0.9
150	50	17±2	<0.2	N/A	N/A	N/A
150	55	20±3	0.6±0.5	N/A	N/A	N/A
150	60	5±1	0.0±0.1	N/A	N/A	N/A
150	65	3±1	0.2±0.3	N/A	N/A	N/A
150	70	0.5±0.2	0.0±0.1	N/A	N/A	N/A
150	75	16±1.5	0.07±0.15	<1	2.3±0.2	1.2±0.5
150	0	0.9±0.3	0.06±0.08	<1	<1	<1
150	15	0.6±0.3	0.003±0.009	<1	0.1±0.1	0.6
150	30	2.2±0.5	0.4±0.2	0.3±0.3	0.6±0.1	<0.6
155	50	24±1	0.1±0.1	N/A	N/A	N/A
155	55	11±1	0.1±0.1	N/A	N/A	N/A
155	60	0.5±0.2	0.0±0.1	N/A	N/A	N/A
155	65	5±1	0.1±0.2	N/A	N/A	N/A

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TABLE 5-1
(continued)

COORDINATES		pCi/g				
X	Y	Plutonium 239	Plutonium 238	Americium 241	Cesium 137	Strontium 90
165	0	0.09±0.13	0.05±0.09	<1	0.1±0.1	<0.7
165	15	2±0.5	0.08±0.13	<1	0.3±0.1	<0.9
165	30	6±0.8	0.4±0.2	<1	<1	<0.6
165	45	2.5±0.5	0.3±0.2	0.3±0.1	0.3±0.1	<0.6
180	50	0.3±0.2	0.2±0.2	<1	<1	<0.7

N/A Not analyzed

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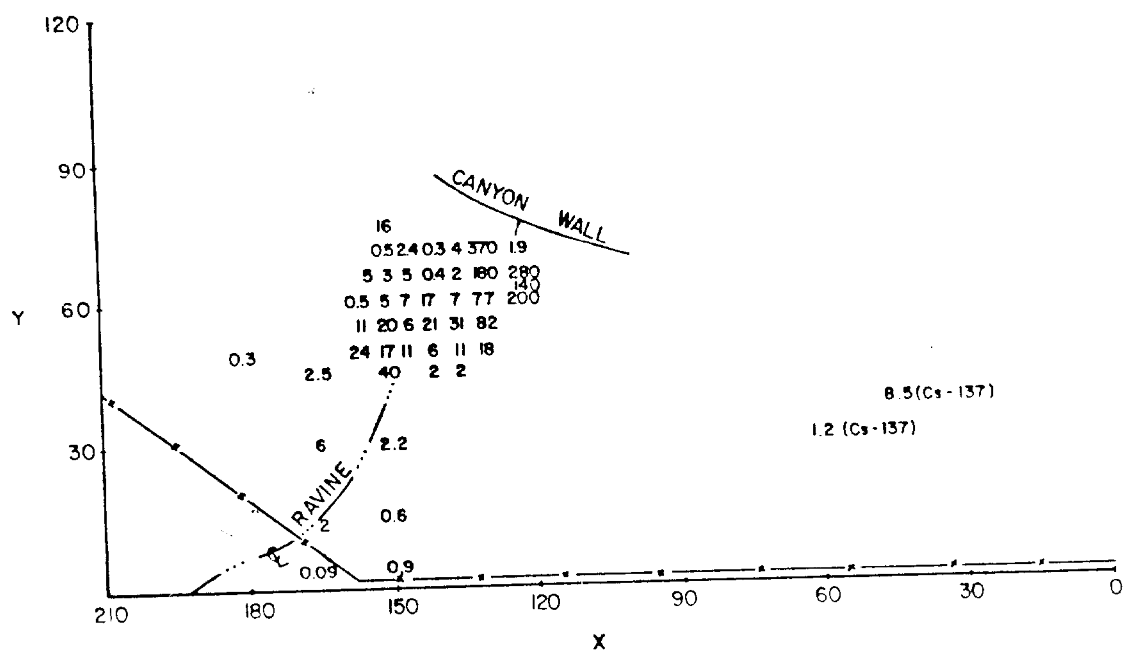

FIGURE 5-1 POST-REMEDIAL ACTION PLUTONIUM-239 CONCENTRATION IN SOIL IN pCi/g (CESIUM-137 INCLUDED TO INDICATE MIXED FISSION PRODUCT CONTAMINATION)

In addition to plutonium analyses, samples collected after the excavation initiated on August 4, 1982 were analyzed for americium-241, cesium-137, and strontium-90. Concentrations of these radionuclides were less than one percent of the applicable guide. Therefore, soil samples collected after hot spot excavation were analyzed only for plutonium-238 and -239. Those samples that were from portions of the site not included in the hot spot cleanup were included for verification purposes. Therefore, 11 soil samples in Table 5-1 include analyses for americium-241, cesium-137, and strontium-90.

Post-remedial action external exposure rates near the untreated waste outfall are presented in Table 5-2. The average exposure rate was 17 uR/h compared to the Los Alamos area average, 9.4 to 17.4 uR/h.

Within the former vehicle decontamination facility area, verification of the adequacy of the remedial action was based on soil sample analysis for the primary contaminants, cesium-137 and strontium-90, and external exposure rates. Based on two soil samples taken in this area the concentration of cesium-137 after remedial action was less than 10 percent of the criterion.

While the primary contaminants were cesium-137 and strontium-90, spotty plutonium-239 contamination also existed in the area as evidenced by one of ten pre-remedial action samples. However, based on these ten samples, the maximum permissable area averaged concentration of plutonium-239 (100 pCi/g) was not exceeded. The requirement to perform remedial action in the vehicle decontamination area was based on the concentrations of cesium-137 and strontium-90 in the soil. Therefore, no analysis for plutonium-239 was performed on post-remedial action samples collected from this area.

The external exposure rate near the former vehicle decontamination facility was 23 μR/h.

TABLE 5-2

ACID CANYON POST-REMEDIAL ACTION

EXTERNAL EXPOSURE RATES (INCLUDING BACKGROUND)

COORDINATES X	COORDINATES Y	EXPOSURE RATE (μR/h)
Former Vehicle Decontamination Facility		
35	30	32
40	30	22
45	40	22
45	45	19
50	45	21
	AVERAGE	23
Untreated Waste Outfall		
135	60	18
140	50	19
140	55	19
140	60	17
145	45	17
150	0	14
150	5	16
150	10	17
150	15	17
150	20	17
150	25	17
150	30	18
150	35	18
150	40	17
150	45	17
150	50	17
150	55	17
150	60	17

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TABLE 5-2
(continued)

COORDINATES X	Y	EXPOSURE RATE (μR/h)
Former Vehicle Decontamination Facility		
150	65	17
150	70	18
150	75	17
155	0	15
155	5	15
155	10	17
155	15	17
155	20	17
155	25	18
155	30	17
155	35	17
155	40	17
155	45	17
155	50	18
155	60	17
160	0	15
160	5	15
160	10	15
160	15	16
160	20	16
160	25	18
160	30	17
160	35	17
160	40	16
160	45	17
160	50	18
160	55	18
160	60	17

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TABLE 5-2

(continued)

COORDINATES X	Y	EXPOSURE RATE (μR/h)
Former Vehicle Decontamination Facility		
160	75	16
165	0	15
165	5	16
165	10	15
165	15	16
165	20	16
165	25	17
165	30	17
165	35	16
165	40	17
165	45	17
165	50	18
165	55	18
165	60	17
170	0	16
170	30	16
170	40	17
170	45	17
175	50	17
180	50	17
185	50	16
	AVERAGE	17

Background exposure rates in the Los Alamos area range from 9.4 to 17.4 μR/h.

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Based on the above analyses and measurements, both the untreated waste outfall and former vehicle decontamination facility were in compliance with the remedial action criteria cited in Table 4-1. Compliance was confirmed by the LANL Environmental Surveillance Group (Reference 13).

5.8 ANALYSIS OF REMAINING CONTAMINATION BEYOND THE TWO REMEDIAL ACTION AREAS

In the first 100 m (30 ft) of the active channel below the rim of Acid Canyon the estimated concentration of plutonium-239 is 154 pCi/g. The maximum concentration measured by the LANL survey was 629 pCi/g. Over the 750 m (2300 ft) length of Acid Canyon the average concentration of plutonium-239 in the active channel is 30.6 pCi/g, while in the banks of the active channel it is 110 pCi/g (Reference 1).

Based on the rough terrain in the canyon and the minimal number of plausible pathways to man there, it was determined that remedial action in the channel was not required. Plausible pathways include resuspension/inhalation and erosion into Lower Pueblo Canyon where gardening is possible. The remedial action criterion for resuspension/inhalation is 7600 pCi/g, which is significantly higher than the contamination levels in Acid Canyon.

While the food/gardening pathway in Acid Canyon was eliminated from consideration, material now in Acid Canyon will eventually erode into Lower Pueblo Canyon. Based on data collected by LANL, the dilution factor between Acid and Lower Pueblo Canyons is six. Consequently, material from Acid Canyon, once diluted and dispersed, will not significantly alter the concentrations of plutonium-239 now in Lower Pueblo Canyon. The maximum concentration of plutonium-239 expected in Lower Pueblo Canyon would be approximately 20 pCi/g or 20 percent of the cleanup criteria based on the sum of all pathways.

[illegible] extrapolation of calculations performed in the 1976-77 radiological survey, the home gardener in Lower Pueblo [illegible] would be expected to receive an annual dose of 0.3 mrem [illegible] and 2 mrem to lung. These doses are a small fraction [illegible] 500 mrem limit for exposure to the general public [illegible] in DOE Order 5480.1A (Reference 14) and represent an [illegible] health risk.

6.0 COST

The total cost of the remedial action at Acid/Pueblo Canyon was $1,037,800. Extensive radiological characterization and subsequent engineering analysis were the major cost contributors. In-depth characterization was essential to ensure that all contaminants were located and identified. In addition, LANL performed extensive modeling of the migration of contaminants from Acid Canyon to Lower Pueblo Canyon to determine whether remedial action was required in the channel of Acid Canyon. This large data base was then assessed in detail to establish the most cost-effective remedial action option. After methodical review of several alternatives, each of which involved a significant amount of preliminary engineering effort, excavation of the contaminated material and disposal at a designated disposal site was selected. This engineering effort resulted in a minimum-cost remedial action solution for the Acid/Pueblo Canyon site which complied fully with all established criteria.

The construction costs were allocated in FY 1982. With the completion of the remedial action, these costs were reduced and in FY 1983 unexpended funds were returned to FUSRAP. The $19,000 cost for disposal of the 390 yd^3 at the LANL site is quite reasonable (approximately $1.80/$ft^3$).

The BNI project costs for FY 1981 were directly influenced by the DOE-ORO policy to apportion all first-year FUSRAP program start-up costs among FUSRAP sites active during that fiscal year. Since BNI assumed the role of the PMC for FUSRAP in April 1981, its start-up costs were applied to eight active sites, including Acid/Pueblo Canyon. The actual cost of FY 1981 activities attributable to each site was not firmly defined because manhour accounting procedures were not fully operational. Consequently each site was allocated an approximately equal share of start-up costs rather than a proportionate one based on actual manhours expended.

The Acid/Pueblo Canyon Cost Summary (Table 6-1) provides a breakdown of cost by fiscal year and discipline. The construction cost appears low when compared with engineering/characterization, radiological, and management costs. Comparison of these costs based on the volume of contaminated material removed is not a valid indication of program effectiveness for two reasons. First, the construction cost was minimized by effective front-end engineering/characterization, which in turn minimized the amount of excavation required. A more appropriate comparison would include radiological/safety and licensing with construction since the former is essential to verification of the remedial action. Second, the costs associated with engineering, radiological characterization, safety, environmental assessment, documentation, and management are less directly related to the volume of contaminated material handled whereas construction cost is a more direct function of this volume.

TABLE 6-1
ACID/PUEBLO CANYON
COST SUMMARY

	1981	1982	1983	Total
ENGINEERING/CHARACTERIZATION				
BNI	18,000	26,600	6,600	51,200
FBDU	32,200			32,200
LANL	59,400	144,000		203,400
NLO	53,000			53,000
ENVIRONMENTAL ANALYSIS				
ANL		43,000		43,000
LANL	74,600	181,000		255,600
RADIOLOGICAL/SAFETY & LICENSING				
BNI	9,000	4,700	8,900	22,600
EIC		32,600	13,800	46,400
LANL-DISPOSAL			6,000	6,000
CONSTRUCTION				
BNI		9,200	[900]	8,300
ZIA		45,000	[25,700]	19,300
PLS		1,400	[300]	1,100
LANL-DISPOSAL			19,000	19,000
MANAGEMENT & SUPPORT				
BNI		89,400	2,100	91,500
APPORTIONED START-UP COST	185,200*			185,200
TOTAL	431,400	576,900	29,500	1,037,800

*Includes 1981 BNI Management and Support Costs.

REFERENCES

1. Los Alamos National Laboratory. Radiological Survey of the Site of the Former Radioactive Liquid Waste Treatment Plant (TA-45) and the Effluent Receiving Areas of Acid, Pueblo, and Los Alamos Canyons, Los Alamos, New Mexico, DOE/EV-0005-30, Los Alamos, NM, May 1981.

2. Bechtel National, Inc. Preliminary Engineering Evaluation of Remedial Action Alternatives, Acid/Pueblo Canyon, Los Alamos, New Mexico, 10-05-01B-001, Oak Ridge, TN, September 1982.

3. Los Alamos National Laboratory. Environmental Analysis of Acid/Middle Pueblo Canyon, Los Alamos, New Mexico, LA-9409-MS, Los Alamos, NM, August 1982.

4. Letter, L. Soholt to K. Harer et al. "Revised ADM for Acid/ Middle Pueblo Canyon Remedial Action," April 16, 1982.

5. U.S. Code of Federal Regulations. 40 CFR 192 "Environmental Protection Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites," Washington, DC, January 1983.

6. Los Alamos Scientific Laboratory. Interim Soil Limits for D&D Projects, LA-UR-79-1865-Rev, Los Alamos, NM, September 1979.

7. Los Alamos Scientific Laboratory. A Preliminary Study of Radium-Contaminated Soils, LA-7391-MS, Los Alamos, NM, October 1978.

8. Letter, E. L. Keller to R. L. Rudolph. "Criteria for Remedial Action at Acid/Pueblo and Bayo Canyons; Request for Cost/Benefit Analyses of Remedial Action Options at the Canyons," March 17, 1982.

9. U.S. Department of Energy. Energy Systems Acquisition Project Plan (ESAPP), Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP), Oak Ridge, TN, December 1983.

10. Bechtel National, Inc. Health and Safety Program, Oak Ridge, TN, March 1982 (revised June 1983).

11. Bechtel National, Inc. Radiological Protection Program, Oak Ridge, TN, May 1982 (revised June 1983).

12. Bechtel National, Inc. Quality Assurance Manual, Oak Ridge, TN, April 1982, (revised March 1983).

13. Los Alamos National Laboratory. Radiological Survey Following Decontamination Activities Near the TA-45 Site, LA-9831-MS, Los Alamos, NM, July 1983.

14. U.S. Department of Energy. Order 5480.1A, "Environmental Protection, Safety and Health Protection Program for DOE Operations," Washington, DC, June 1982.