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LOS ALAMOS SCIENTIFIC LABORATORY
of the
University of California
LOS ALAMOS • NEW MEXICO

Los Alamos Environmental Monitoring Program

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by

Environmental Services Group

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ABSTRACT

The Los Alamos Scientific Laboratory complex includes accelerators, research reactors, radioactive materials separation facilities, and other experimental installations using radiation or radioactive materials. In operation of the Laboratory, certain radioactive wastes are generated and must be disposed of.

An outline is given of the surveillance methods used throughout Los Alamos County and outside restricted areas to determine the effect of Laboratory operations on the environmental radioactivity. Gamma radiation measurements are routinely made. Scheduled samples of air and water are taken, assayed for gross alpha and beta activity, and also for certain specific nuclides which may be present in some concentration. Soil samples are taken when considered necessary.

INTRODUCTION

Los Alamos County, New Mexico, an area of approximately 108 square miles, lies on the eastern slope of the Jemez Mountain range. It is bordered on the southeast by the Rio Grande (altitude 5,400 ft above m.s.l.) and on the west by the peaks of the Jemez range (altitude approximately 10,500 ft above m.s.l.). The area has an average annual rainfall of 18 in. Drainage is in general from west to east, and the area is cut into finger-shaped mesas by this drainage. Stream flow in the canyons is seasonal, dependent on snow run-off and thunderstorm activity. The townsite is centrally located in the county on a series of such mesas at an altitude of approximately 7,000 ft above m.s.l. See Fig. 1.

The various work sites throughout the Los Alamos Scientific Laboratory complex are south of the townsite. The work sites occasionally release small amounts of radioactive materials to the atmosphere and to the stream beds in the different canyons. These materials are a possible source of radiation exposure. Radioactive trash is buried in restricted burial areas, the choice of site being governed by the improbability of future leaching of long-lived activities into possible drinking or irrigation water sources. Personnel of the U.S. Geological Survey, Albuquerque, New Mexico, determine the suitability of such areas. For locations of such sites see Fig. 2.

The Environmental Monitoring Program was initiated to determine how much. if any, increase in radiation exposure to the population has occurred due to activities of the Laboratory. This program has grown in

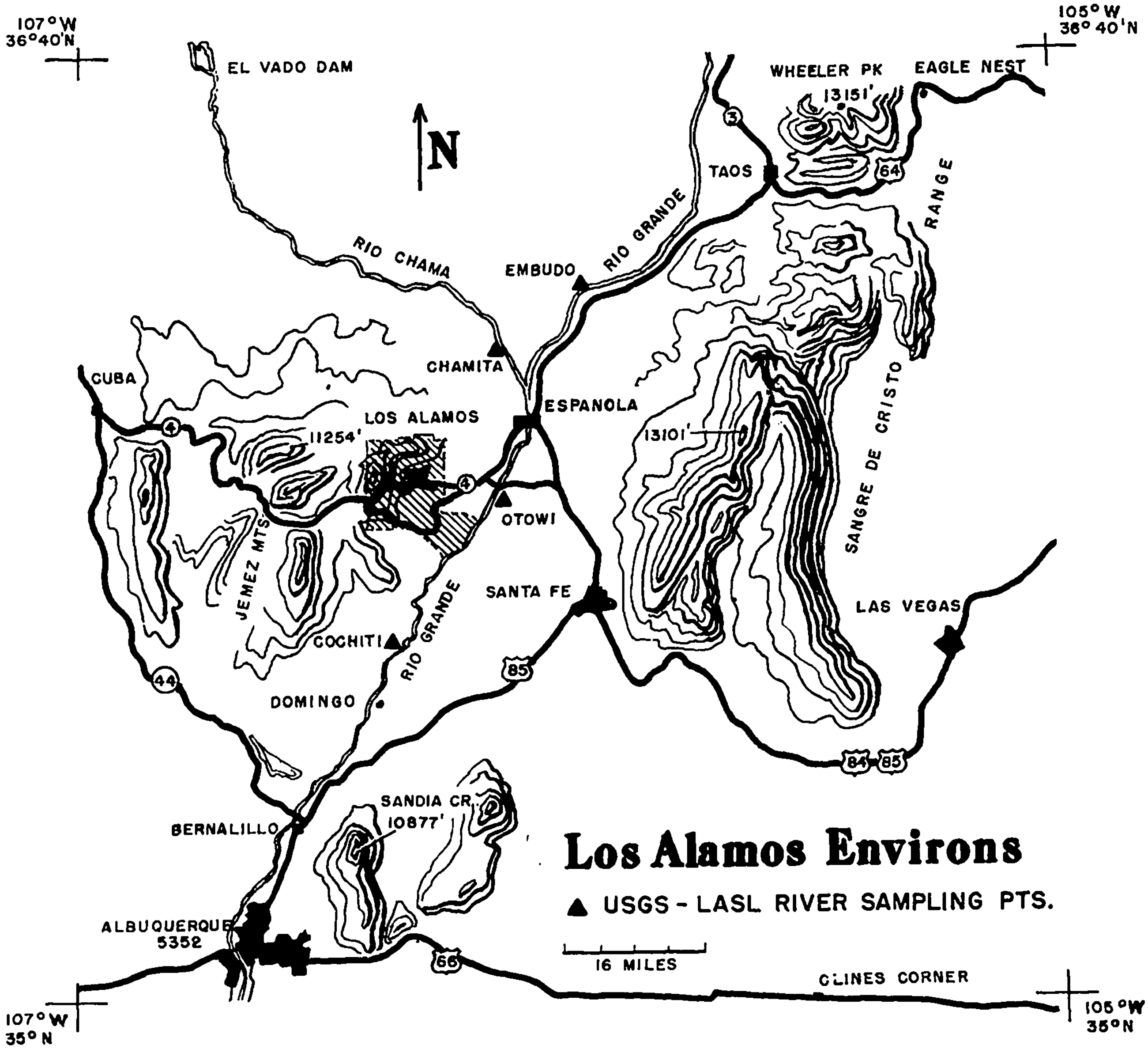

Fig. 1. Los Alamos Environs

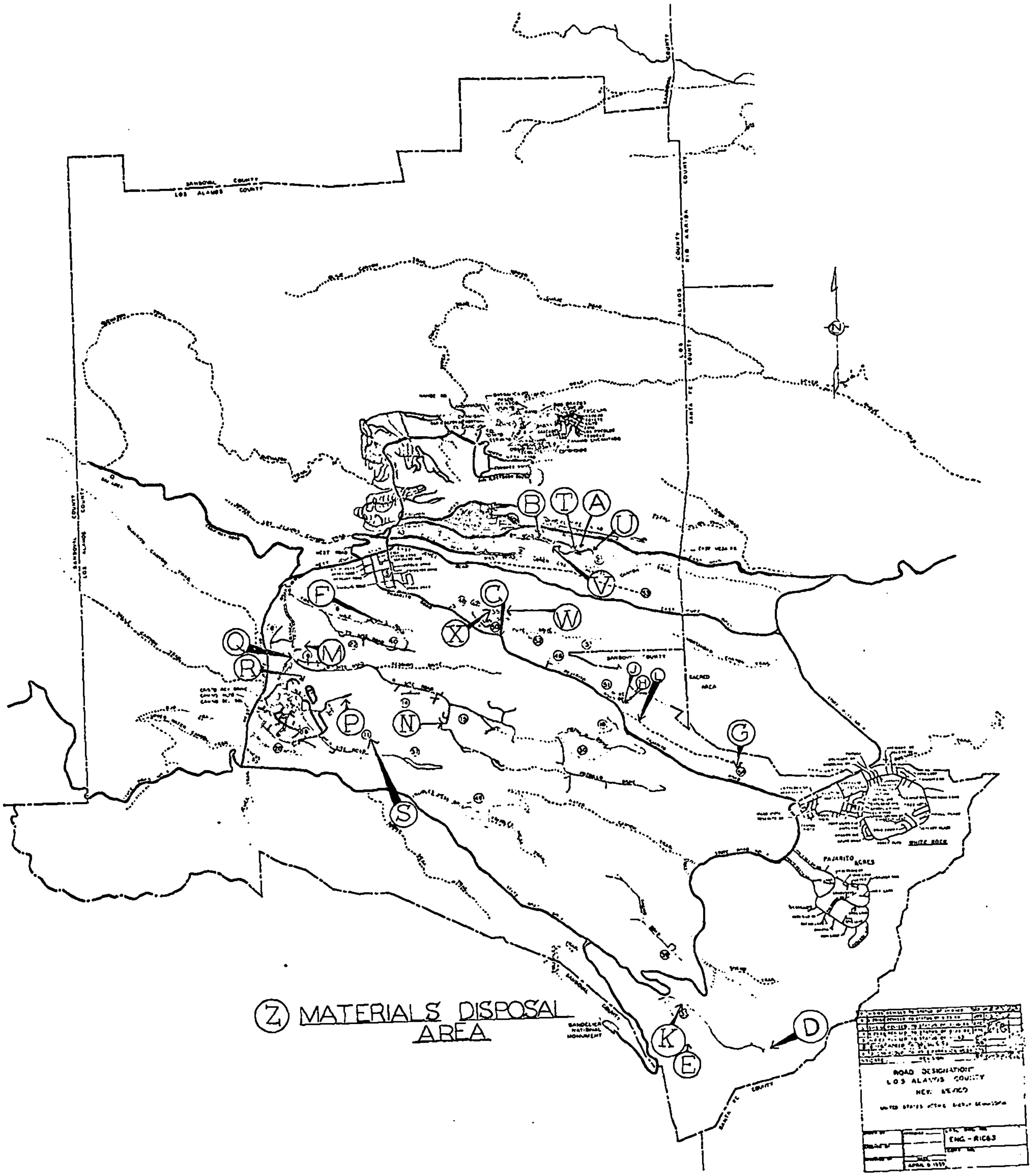

Fig. 2. Radioactive Waste Burial Pits

size and scope as deemed necessary. The measurements being made include gamma-ray background; air particulate sampling for alpha, beta, and gamma radiation emitting materials, and water sampling and assaying for certain specific radioactive materials.

GAMMA-RAY MEASUREMENTS

There are approximately 60 stations throughout the County where thermoluminescent dosimeters are planted on stakes at approximately 3 ft above ground. The stations are located both in the townsite and along various roads throughout the Laboratory sites. For station locations see Fig. 3. The dosimeters are exchanged, read, and readings are recorded every month. The sensitivity of the dosimeters is such that natural background, due to cosmic radiation and the presence of normal amounts of naturally occurring radioactive isotopes in the air and soil, is detected. Man-made radiation or radiation resulting from environmental contamination is also detected and measured. In case of an accidental release of a large amount of gamma-active gases or particulates, the fallout path and doses administered can be determined.

AIR SAMPLING

Air sampling has been carried on throughout the residential community and at the County perimeter for several reasons. First, minute amounts of radioactive particulates and short-lived radioactive gases are routinely or continuously released by the operations in the various laboratories and research reactors. Second, an accidental release of large amounts of such activities might occur, and we would need the sampling information to evaluate the seriousness of the release. Third, the information is available in cases of public relations questions.

In areas generating radioactive particulates, samples of stack effluent are continuously taken by the Health Physics Group both before and after filtering the air. Amounts of activity released as particulates to the environment can thus be calculated to some degree of accuracy. Sampling of the air where people live and work is performed to determine the ultimate fate of such materials released.

The same holds true for those areas releasing short-lived radioactive gases, where samples of effluent air are taken before and after delay loops or dilution with atmospheric air.

A. AIR SAMPLING METHODS

All environmental samplers are operated on a continuous basis. Two types of sample equipment are used.

1. A positive displacement rotary blower, Roots-Connersville Type AF, Size 29, is used to pull air through a Mine Safety Appliance 4-in.-diam respirator particulate filter, MSA No. CR-17651. The filter is followed by MSA charcoal respirator cartridge, BM-2306, to catch iodine. The sampling rate is 25.5 m^3/h. The rate is checked periodically using a shop-made orifice meter which has been calibrated against a standard gas-meter prover.

The filter samples are collected on a workday basis. The CR-17651 filter is counted for gross beta activity using a gas proportional counter calibrated against a $^{90}Sr-^{90}Y$ equilibrium standard. Overall geometry efficiency is 50%. The filters are counted at 10 min, 5 h, 24 h, and 7 days after collection. The 7-day value is reported in units of microcuries of activity per cubic centimeter of air sampled. There are two such samplers running in the County. The purpose of the samplers is to measure the rate of deposition at Los Alamos of the world's atmospheric burden of radioactive debris, predominantly from weapon tests. By comparison of our results with similar installations at Santa Fe, New Mexico, operated by the Department of Public Health, and at Albuquerque, New Mexico, operated by Sandia Laboratories, any anomaly due to local Laboratory activity can be determined. The cartridge,

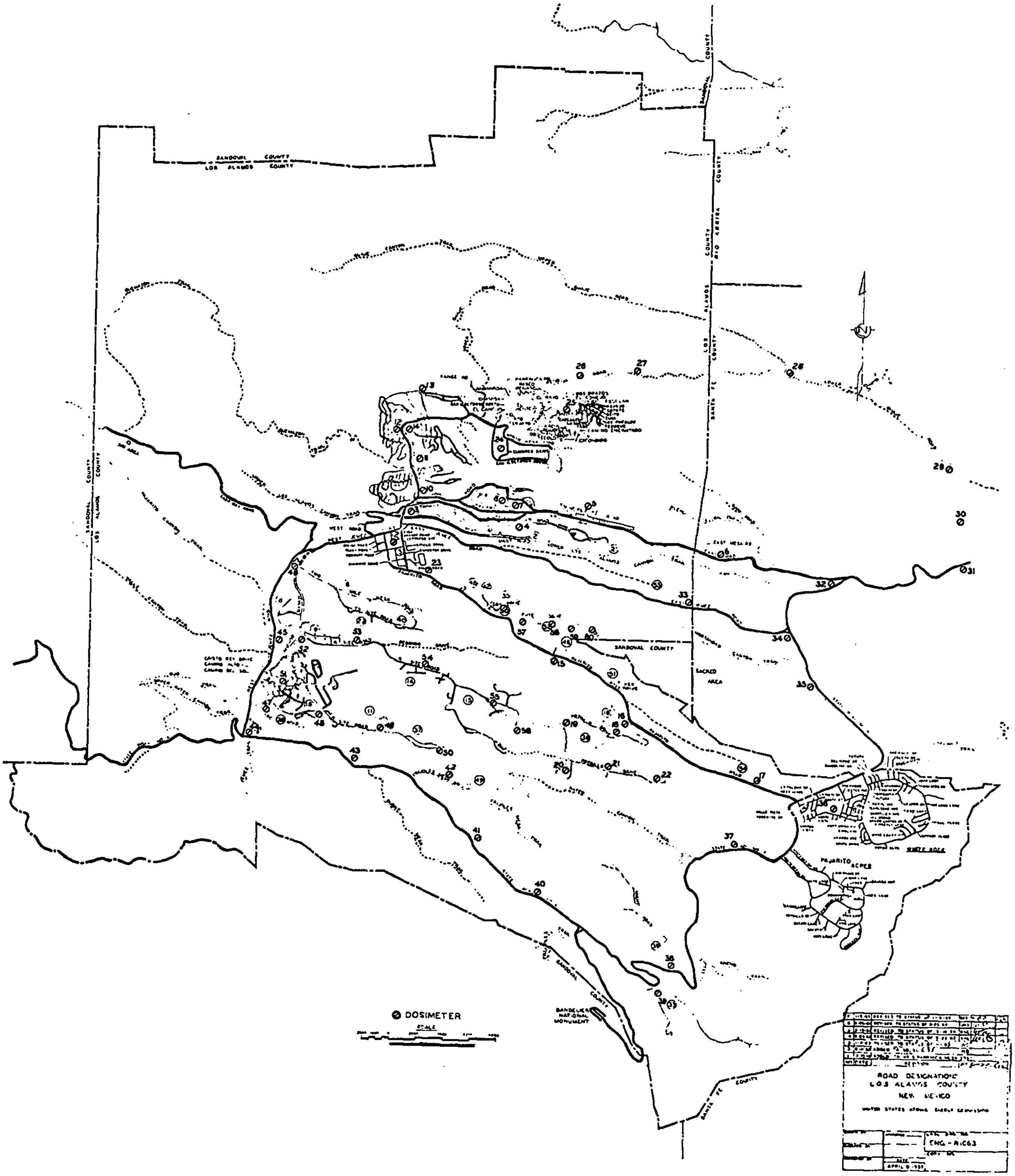

Fig. 3. Dosimeter Stations

BM-2306, is analyzed on the gamma spectrometer. The sample is counted on a 3 in. by 3 in. Harshaw NaI(Tl) crystal in a massive steel shield. The analyzer used is a Packard 400-channel analyzer. The standard used is a similar cartridge, torn down, spiked with a standard ^{131}I solution, and reassembled. Data are retrieved on a Tally paper punch tape, transferred to IBM cards, and put through an IBM computer for spectral analysis using a least-squares-analysis program. The resultant numbers are then corrected for decay to mid-point of collection, and for volume, and are reported in microcuries per cubic centimeter, which makes them readily comparable with the Radioactivity Concentration Guide figures in the Appendix, Annex A of AEC Manual Chapter 0524, "Standards for Radiation Protection."

2. The second type of air sampler used for environmental sampling was designed to look primarily for alpha-active particulates.

Twenty-four such stations are serviced weekly at various locations throughout the residential community and the perimeter of the County (see Fig. 4). The sampling stations were picked in some cases because of available power and limited access by the public.

The equipment used consists of a centrifugal compressor, Leiman Bros. Model KC or KM, pulling air at 2 ft^3/min through a Gelman AM-3, 2-in.-diam membrane filter. In seven samplers, the membrane filter is followed by an MSA respirator cartridge, GMA Cat. No. CR-44135, for ^{131}I sampling. The flow rates are also checked periodically with a shop-made orifice meter calibrated against a standard gas-meter prover.

The membrane filter samples are prepared for counting by backing the filter with a 1/32-in.-thick steel or copper disk and wrapping the filter and disk in 0.0005-in. Mylar. The covering is to prevent possible contamination of the counting chamber, and the backing is to give sample rigidity and a standard backscattering of the alpha particles.

The samples are counted in a Sharp Wide Beta gas proportional counter calibrated in the alpha channel with a standard ^{239}Pu source. Before evaluating the sample for possible plutonium contamination, it is necessary to allow for radioactive decay of the naturally occurring short-lived radon and thoron daughter products. The samples are screened for gross anomalies following collection. However, the values recorded are those determined after a 1-week delay following collection.

The lower limit of our system's detection ability is approximately one-tenth of the value for effluent air in unrestricted areas as specified in the Appendix, Annex A of AEC Manual Chapter 0524.

Should the above values be exceeded, after purification and concentration, identification of the activity is made by using the alpha pulse-height spectrometer. The present system is a semiconductor alpha detector going to a Nuclear Data multi-channel analyzer.

The CR-44135 cartridges are treated as mentioned above for the BM-2306. A median efficiency of collection of ^{131}I of 90% is assumed. (LA-3363, "Iodine-131 Sampling with Activated Charcoal and Charcoal-Impregnated Filter Paper," 1965, H.J. Ettinger and J.E. Dummer, Jr.) (Ref. 1)

The filter samples, type CR-17651, are saved for further chemical analysis. Periodically, they are pooled by the month, wet ashed, and specifically analyzed for the following radioactive nuclides: ^{90}Sr, ^{137}Cs, and the ^{144}Ce group. Methods of analysis and results are given in LAMS-2878, "Strontium-90, Cesium-137, and Radioactive Rare Earths in Environmental Rain and Air at Los Alamos, New Mexico 1958 - June 1963," 1964, E.R. Graham. (Ref. 2)

FALLOUT AND PRECIPITATION SAMPLING

As part of fallout sampling, rain water is collected and counted. The collector is a large rain gauge designed to

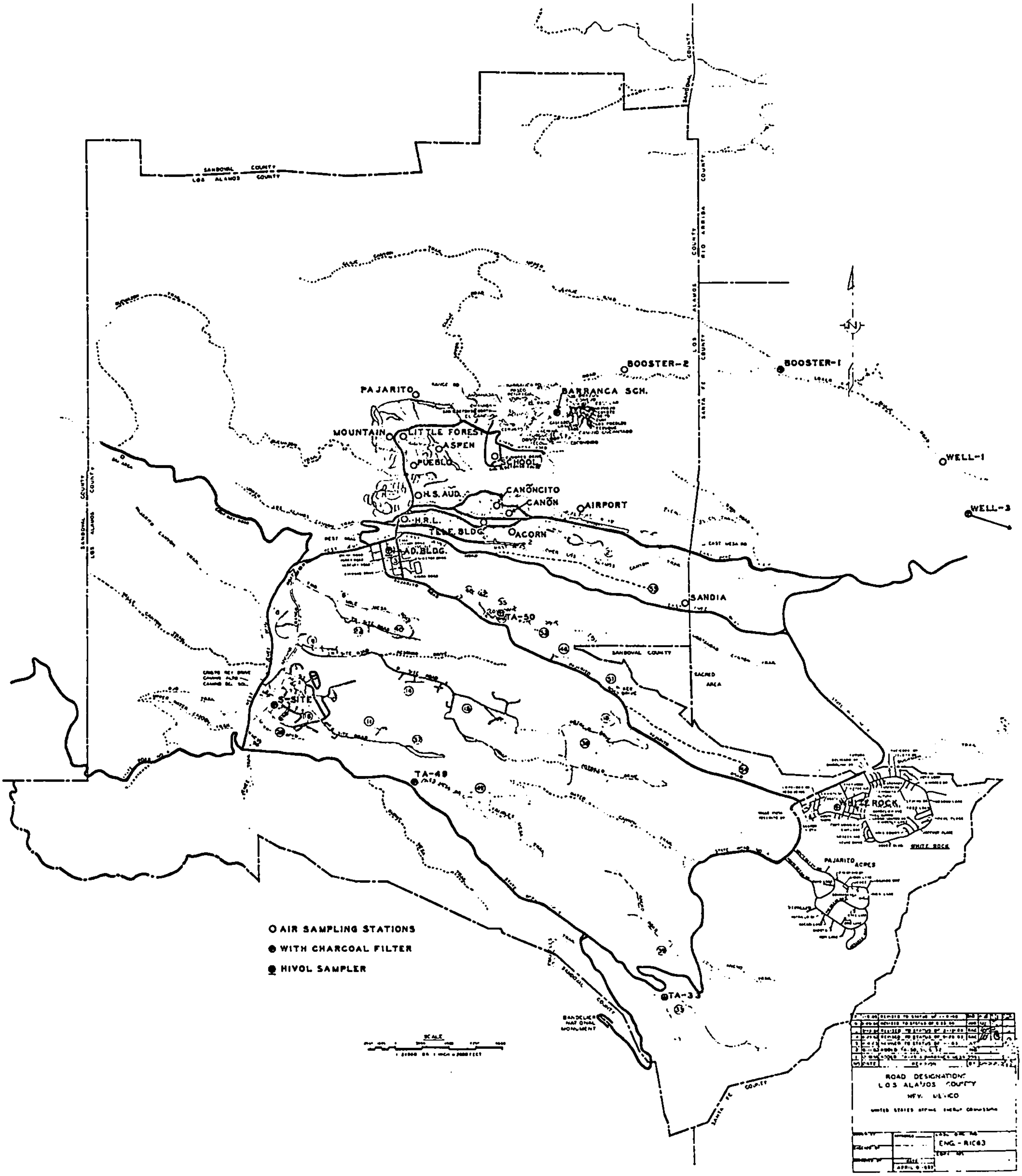

Fig. 4. Air Particulate Sampling Stations

catch 1 liter of water for every 0.1-in. precipitation. The area of the collecting surface is 0.4 m^2. The sampling is done on a workday basis; precipitation is recorded in inches. The collector is rinsed down with 1 liter of distilled water, which is added to the precipitation sample, if any. The sample is boiled down to dryness after removing any foreign matter such as insects, pollen, leaves, or seeds.

The residue is counted for gross beta activity in the Sharp Wide Beta proportional counter. The counter is calibrated with a Tracerlab radiolead standard emitting betas of 1.17 MeV maximum energy. The results are reported as picocuries per square meter of collecting surface. Unusually high activity residues are further subjected to gamma-ray spectroscopy.

Periodically, the samples are pooled by the month, wet ashed, and specifically analyzed for ^{90}Sr, ^{137}Cs, and the ^{144}Ce group. Methods of sample preparation, analysis, and results are given in Ref. 2.

WATER SAMPLES

LASL Group H-6 at present maintains over 50 water sampling stations. These consist of wells, springs, surface streams, and ponds. Wells fall into two general categories: observational research wells and water supply wells. Some surface water is occasionally used for domestic or commercial purposes at Los Alamos, but for the most part the domestic and industrial water supply comes from deep wells. The water sampling program is intended to maintain a knowledge of the ultimate fate of contamination released to the Los Alamos environment, to determine as soon as possible any actually or potentially hazardous condition due to concentration, and to accumulate a reliable set of records.

In general, a 1-gal sample is taken at each station for radiochemical analysis and a 1-qt sample for chemical analysis.

A. River Samples
(For station locations see Fig. 1.)

Surface water samples are collected from the Rio Chama at Chamita and from the Rio Grande at Embudo, Otowi, and Cochiti. Samples are collected three to four times a month at Chamita, one to two times a month at Embudo and Cochiti, and daily at Otowi. The samples are combined into composite quarterly samples and analyzed for chemical and radiochemical constituents.

The water in the rivers has a natural uranium content of the order of 10^{-9} $\mu Ci/cm^3$, this being approximately 1/5000 of the Concentration Guides (CS's) for natural uranium listed in AEC Manual Chapter 0524.

B. Springs and Seeps
(For station locations see Fig. 5.)

Seven intermittent surface water sources are sampled on a bimonthly or semiannual basis, depending upon accessibility and whether the source is flowing. Grab samples are taken for analysis. The uranium content is similar to that in the river water.

C. Supply Wells
(For station locations see Fig. 5.)

There are 16 supply wells located in four different canyons between Los Alamos and the Rio Grande. Grab samples are taken in mid pumping cycle. All are sampled semiannually.

D. Test Wells
(For station locations see Fig. 5.)

There are nine wells to various levels of perched water, or to the water table, which are sampled periodically. Some have pumps installed and are pumped continuously at rates of 2 to 4 gal/min to keep a continuous flow toward the well bore. Grab samples are taken for analysis.

The others are sampled using a bailer, several bailers of water being discarded before a sample is taken.

E. Observation Wells
(For station locations see Fig. 5.)

Groundwater samples are collected bimonthly from observation wells in Mortandad Canyon. Samples are also collected periodically from observation wells in Pueblo Canyon. The wells in the alluvium in the canyon bottom range in depth from 12 to 80

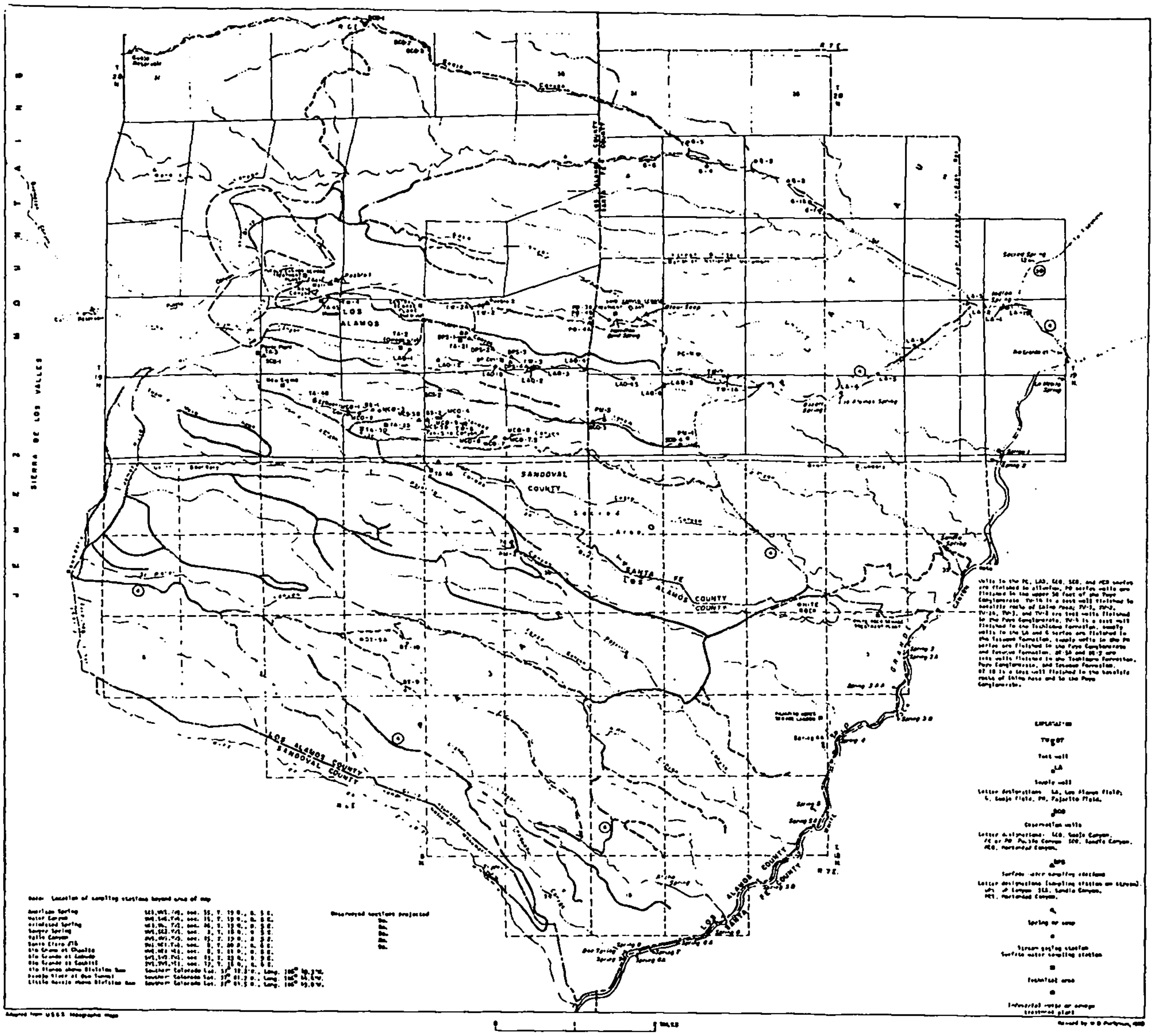

Fig. 5 Water Sampling Stations in the Los Alamos Area

ft. The sources of the water are treated industrial effluent, cooling water, and storm run-off. These wells are not equipped with pumps; consequently, the samples are collected by bailing with a brass bailer. One to three bailers of water are removed from the well and discarded before the sample is collected.

F. Alluvium

Alluvium is collected from the stream channel in the disposal system in Mortandad Canyon and analyzed for radioactivity. The samples are collected at the surface and at intervals of 1, 2, and 3 ft by use of a 3-in. hand auger. The surface sample depth is referenced to a permanent reference stake. The alluvium is placed in a half-pint carton for delivery to the laboratory.

G. Chemical Analysis of Water Samples

The chemical analyses are made to determine pH, conductivity, phenolphthalein alkalinity, methyl orange alkalinity, total hardness, and content of calcium, magnesium, sodium, chloride, fluoride, nitrate ion, and total solids. Methods used are to be found in "Manual on Industrial Water and Industrial Waste Water," (2nd Ed.) ASTM Special Technical Publication No. 148-E (Ref. 3). These analyses are done by the Waste Treatment Group.

H. Radiochemical Analysis of Water Samples

The radiochemical analyses made are:

1. Plutonium. Anion exchange adsorption followed by selective elution of plutonium and electrodeposition of a clean monomolecular layer of activity together with a ^{236}Pu tracer for efficiency measurement are carried out. Alpha pulse-height analysis is done using a Nuclear diode silicon detector feeding into a Nuclear Data multichannel analyzer. A value of 2×10^{-10} μCi/ml is considered significant by the method of analysis. See Refs. 4 and 5 for method.

2. Uranium. The fluorescence of a sodium lithium fluoride bead method is used. We consider a value of 0.5 μg U/liter as significant. A Turner fluorometer is used for the determination. See Ref. 6.

3. Tritium. Liquid samples are routinely analyzed for tritium by the liquid scintillation method. A volume of 0.5 ml of sample is mixed with a standard dioxane "cocktail" and counted on a Beckman LS200 counter. A value of 1×10^{-4} μCi/ml is considered significant by the method of analysis.

4. Gross Beta. After evaporation of a 1-liter water sample, the residue is counted in a small dish. A value of 1×10^{-8} μCi/ml is considered significant. The Sharp Wide Beta proportional counter is used.

I. Soil Samples

To date, soil sampling at Los Alamos has not been carried out on a regular schedule but rather to fit specific needs or to augment other environmental investigations. Such special investigations have been required on occasion in cleanup operations following the abandonment of working sites. Sampling has been done using augers, spatulas, etc., depending upon the depth required. Samples have been ground and pulverized by commercial equipment. The dried sample is thoroughly mixed in a Patterson-Kelly blender prior to taking an aliquot. The aliquot is subjected to a nitric acid leach which may be counted for gross beta-gamma activity. A portion of the leach may be run through a strontium separation[7] ending with a strontium carbonate precipitate which is counted before appreciable ingrowth of yttrium, or strontium analysis will be made as a function of yttrium-90 growth following solvent extraction.[8] Plutonium and uranium determinations are performed in a manner similar to those used for water samples.

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