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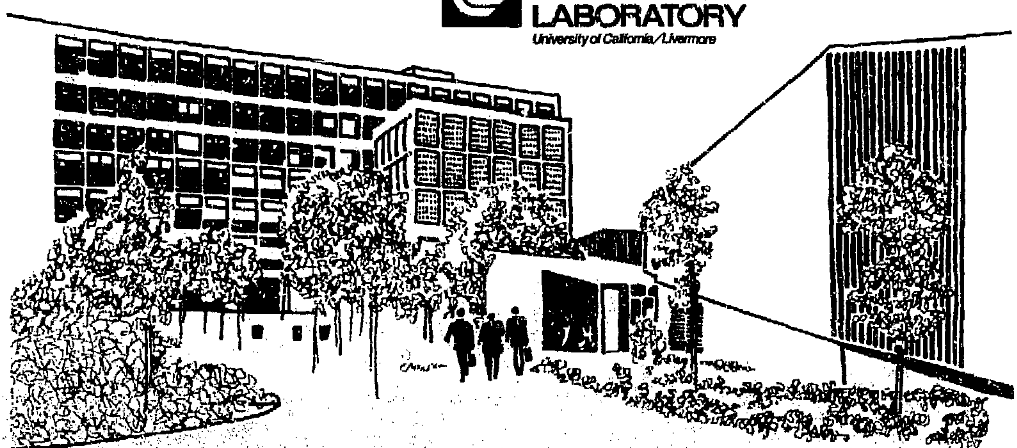
ENVIRONMENTAL MONITORING AT THE LAWRENCE LIVERMORE LABORATORY

1974 ANNUAL REPORT

W. J. Silver
C. L. Lindeken
J. W. Meadows
E. H. Willes
D. R. McIntyre

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48

LAWRENCE LIVERMORE LABORATORY
University of California/Livermore



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Foreword

This report is prepared for the U. S. Energy Research & Development Administration by the Environmental Evaluations Group of the Hazards Control Department, Lawrence Livermore Laboratory. Data are obtained through the combined efforts of the Radiochemistry Division, the Bio-Medical Division and the Hazards Control Department. In addition to the authors listed, the following personnel made significant contributions to this report:

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Contents

List of Tables

ENVIRONMENTAL MONITORING AT THE LAWRENCE LIVERMORE LABORATORY

1974 ANNUAL REPORT

Introduction

The Lawrence Livermore Laboratory (LLL) is located about 64 km (40 mi) east of San Francisco in the Livermore Valley in southern Alameda County, approximately 5 km (3 mi) east of the City of Livermore, California. The site occupies an area of 2.54 km^2 (627 acres, approximately 1 mi^2). Open agricultural areas surround the Laboratory on the north, east, west, and part of the south side. Sandia Laboratories — Livermore occupies a portion of the adjoining property on the south.

Established in 1952, the Laboratory is operated for the Energy Research and Development Administration by the University of California under contract number W-7405-Eng-48 and currently employs approximately 5600 people. Although nuclear weapons research and development has always been the prime mission of LLL, additional programs include controlled thermonuclear research, peaceful uses of nuclear explosives, biomedical studies and laser fusion research. Most recently, major programs to develop non-nuclear energy technologies have been established at Livermore.

Much of the materials testing and high-explosive diagnostic work of the Laboratory is carried on at Site 300, about 16 km (10 mi) southeast of Livermore. This site, located in the sparsely populated hills of the Diablo Range, covers an area of 27 km^2 (7000 acres).

The Livermore Valley has a climate characterized by mild, rainy winters and warm, dry summers. Annual rainfall averages about 360 mm (14 in.); rains occur predominantly between November and April, usually in connection with Pacific storms. Surface water drainage from the Valley is from east to west through various arroyos with the outfall in the southwestern corner of the valley. Prevailing winds are from the west and southwest during April through September. During the remainder of the year, the winds from the east and northeast often occur as frequently as those from the west and southwest.

The Livermore site is developed on a northwesterly sloping alluvial flood plain bordering the low hills of the Livermore Uplands to the south. Lithology of the area consists of a series of unconsolidated marine and continental sedimentary units such as sandstones, gravels, silts, and clays overlaying the interbedded sandstones of the Franciscan Formation. The hilly terrain surrounding the Valley is used for cattle and sheep pasture. Principal agricultural products in the vicinity of LLL are grapes and wine, cattle, poultry and eggs.

Water bodies adjacent to the Laboratory include the South Bay Aqueduct at a closest distance of 1.8 km (1.1 mi) to the southeast; the Patterson Pass water treatment facility about 2 km (1.3 mi) east of LLL; and Frick Lake 4 km (2.5 mi) north of LLL. (Frick Lake is dry most of the year.) LLL normally receives all of its treated water from the Hetch Hetchy Aqueduct (which supplies San Francisco), located 11 km (7 mi) southwest of Livermore. Laboratory storm water is channeled through storm sewers designed to accommodate a 10-year flow. Open ditches are used in undeveloped areas of the site. Two arroyos traverse LLL. Arroyo Seco crosses at the southwest corner of the project, and Arroyo Las Positas originally crossed the northeast section of the site, entering from the east at a point on Greenville Road between Patterson Pass Road and Lupin Way. However, in 1965, as part of an erosion control program the arroyo was channeled north to the northeast corner of the site, and then west along the north perimeter to an outlet at the northwest corner. This outlet, which also constitutes the principal pathway for the Laboratory's surface drainage (storm and irrigation) runs north in a 5.7×10^{-3} km^2 (1.4 acre) easement zone to the Western Pacific tracks, then westward where it joins Arroyo Seco.

The total present population within 80 km (50 mi) of the Laboratory is approximately 4.3×10^6. The nearest urban residential area is 0.8 km (0.5 mi) from the west perimeter.

A strict effluent control program, which places maximum emphasis on controlling effluents at the source, has been in continuous existence within the Laboratory since it began operation. An environmental surveillance program is conducted to ensure that this control program is indeed restricting the release of effluents from the Livermore Laboratory and Site 300 to concentrations well below applicable standards. This program employs techniques with sensitivities usually capable of detecting radioactive and non-radioactive pollutants below environmental background levels. The program includes the collection and analysis of air, soil, water, sewer effluent, vegetation, and milk samples. Environmental background radiation is measured at numerous locations in the vicinity of the Livermore Laboratory by means of thermoluminescent detectors.

The results of the analyses are provided in this report. When appropriate, maximum, minimum, and average concentrations are given. Error limits, when included, reflect the uncertainties in the analyses at the 95% confidence level due to counting statistics. Unless otherwise stated, the minimum detection limit of these measurements is assumed to have been reached when the 2 σ error is $\pm 100\%$. In the case of radioactivity, an attempt has been made to assess the impact from the observed environmental activity levels of artificially and naturally produced radionuclides by calculating the whole-body or critical organ doses delivered to an adult by the various radionuclides of interest. In evaluating these radiation doses, which are typically less than 1 mrem per year, it should be remembered that doses of approximately 100 mrem are received each year from natural sources.

Summary

In 1974, the average annual gross beta activity on particulate air filters was about five times higher than in 1973. This increase is due almost entirely to the nuclear debris added to the stratosphere by the large-yield Chinese atmospheric event of June 27, 1973. There were corresponding increases in specific fission-product radionuclides. Airborne ^{238}U concentrations at Site 300 were higher than those at Laboratory perimeters due to the use of "depleted" uranium (a byproduct of ^{235}U enrichment) at the Site. These uranium concentrations were well below the standards set by the AEC.

Soil samples collected in the off-site vicinity of the Laboratory and at Site 300 were analyzed for plutonium. There were negligible changes from the levels reported in 1973.

Water samples collected within the Livermore Valley and Site 300 exhibited normal background gross beta and tritium activities. Vegetation samples collected in areas generally downwind from the Laboratory contained tritium activities 10 to 100 times higher than those collected in areas where the Laboratory's contribution should be minimal. There were also two locations at Site 300 at which tritium levels in vegetation were above background. In all cases if this vegetation were a regular part of one's diet, the annual whole-body radiation dose from tritium would be less than 1 mrem.

The average annual gamma dose rate at Laboratory perimeters was 74 mrem. In the off-site vicinity, the average annual background dose rate was 68 mrem. Both Laboratory perimeter and Site 300 annual average airborne beryllium concentrations were less than 1% of the appropriate standard. Releases of heavy metals to the Livermore sanitary sewer system conformed to the discharge regulations of the City of Livermore.

No Laboratory effluent resulted in estimated radiation doses to the public exceeding 5 mrem. Assessment of the radiation doses to an individual from the environmental activities listed in this report demonstrates that the dose contribution from Laboratory operations in 1974 was small compared with the approximately 100 mrem per year dose received from natural sources.

Monitoring Data — Collection, Analysis and Evaluation

RADIOACTIVE MONITORING

Airborne Radioactivity

Concentrations of various airborne radionuclides were measured at Laboratory perimeters, in the off-site vicinity of the Laboratory and at Site 300. Sampling locations are shown in Figs. 1, 2, 3, and 4, respectively. The six samplers on the Laboratory perimeter and the ten samplers at Site 300 use $5.2 \times 10^{-2} m^2$ (80-in.^{2}) Whatman 41 cellulose filters. These samplers are operated at an average flow rate of 700 ℓ/m (25 cfm). Off-site samples throughout the Livermore Valley use 4.56 $\times 10^{-3} m^2$ (7.07-in.^{2}) glass fiber filters (Flanders F-700) and are operated at

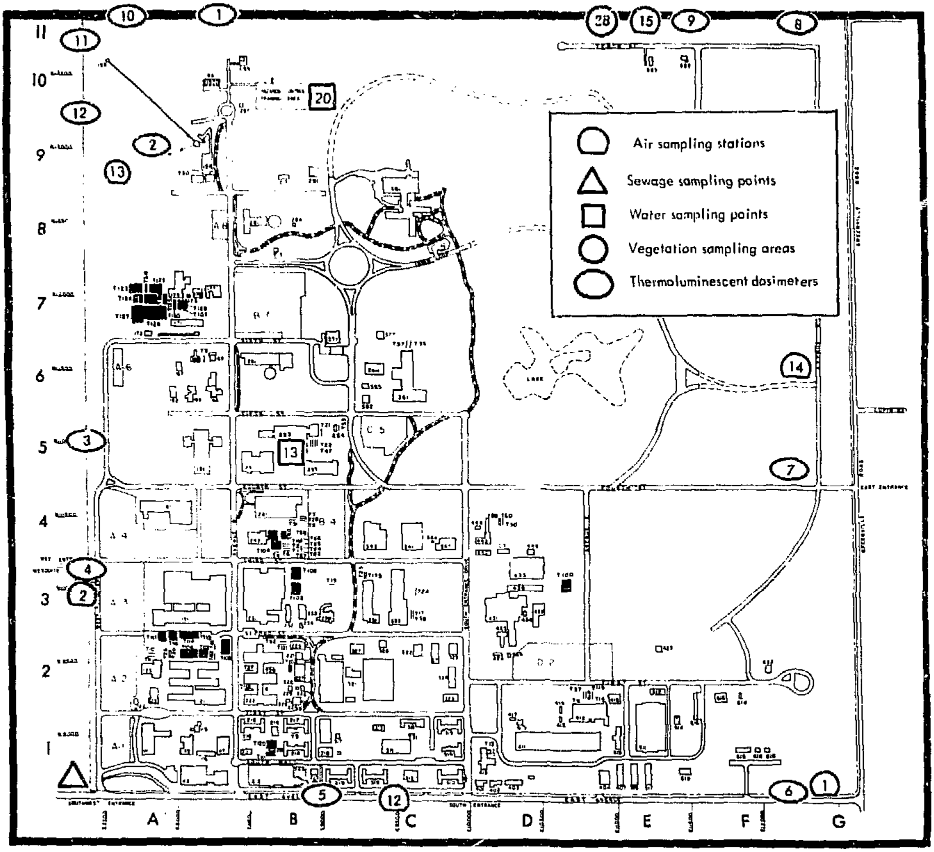


Fig. 1. Lawrence Livermore Laboratory on-site environmental sampling locations.

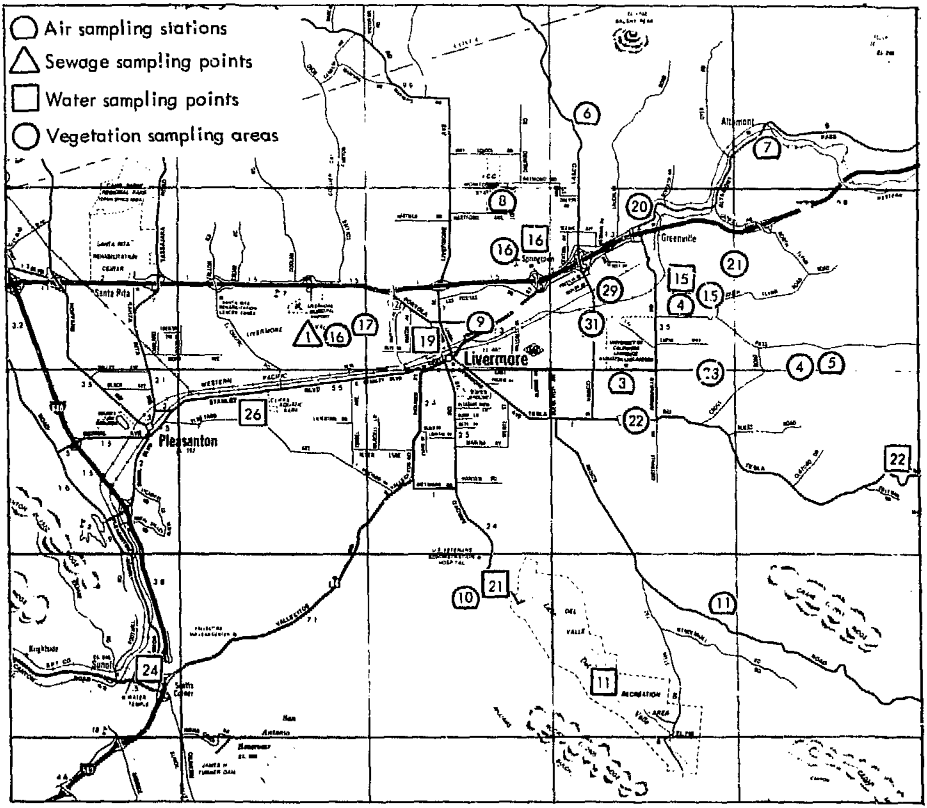


Fig. 2. Lawrence Livermore Laboratory off-site environmental sampling locations.

80 ℓ/m (3 cfm). All air filters are changed weekly. Perimeter and Site 300 filters are cut in half, and a half of each filter is retained for beryllium analysis (see Non-radioactive Monitoring).

After a four-day delay for the decay of radon-thoron daughters, gross alpha and beta activities on the filters are determined using an automatic gas flow proportional counter. Monthly composites of the Laboratory perimeter and Site 300 filters are also counted for specific gamma-emitting radionuclides by means of a Ge(Li) detector equipped with Compton suppression.[1] Following gamma counting, the monthly composite of the Laboratory perimeter filters is divided according to sampling location. These samples and the Site 300 composite are analyzed for ^{239}Pu, ^{238}Pu, ^{90}Sr, ^{235}U, and ^{238}U.

No gross alpha activity above the 1×10^{-15} μCi/ml minimum detection limit was observed on the filters. Tables 1 and 2 show airborne gross beta activities on the

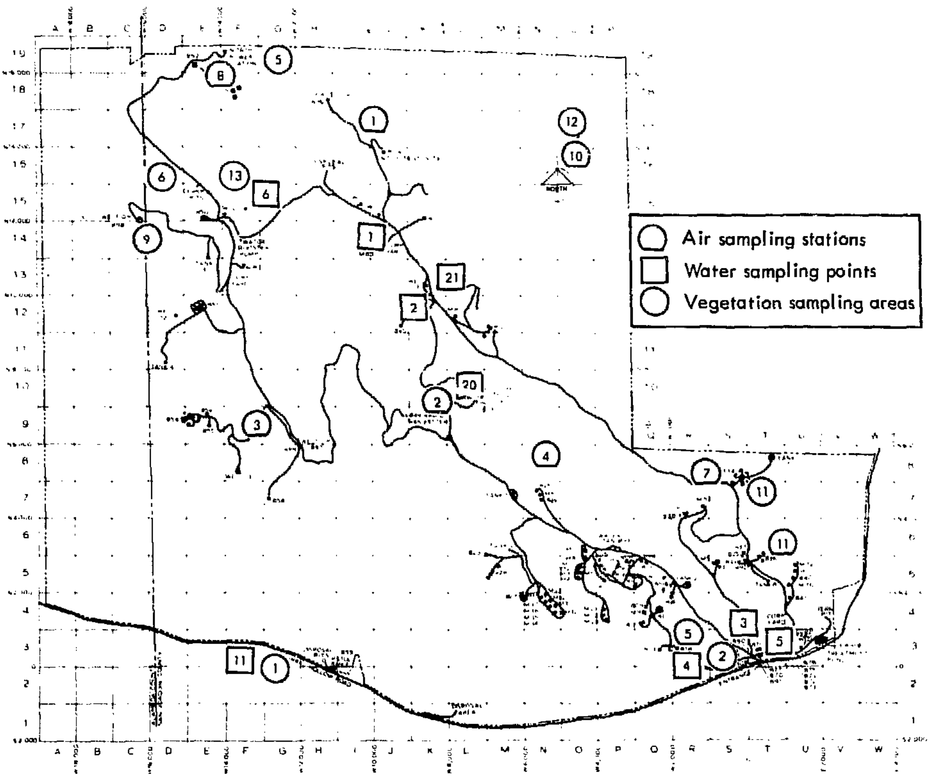


Fig. 3. Air, water and vegetation sampling locations inside Site 300 boundary.

Livermore Valley and Site 300 samples respectively. Average annual concentrations are about five times higher than those found during 1973.[2] This increase is due almost entirely to the large-yield Chinese atmospheric event of June 27, 1973 which added considerable nuclear debris to the stratospheric inventory. Figure 5 is a plot of the weekly average beta activities at the two sites, and shows the increase typically observed during spring months due to transfer of radioactive debris from the stratosphere to the troposphere. Tables 3 and 4 list the activities of the more abundant gamma-emitting radionuclides which contribute the bulk of the beta activity in Livermore and Site 300 samples. Tables 5 and 6 show the concentrations of airborne ^{239}Pu, ^{238}Pu, ^{90}Sr, ^{235}U, and ^{238}U in Livermore perimeter and Site 300 air samples. Both sets of data show plutonium and strontium concentrations comparable to those observed last year, and which are typical of global fallout.[3,4] The higher concentration of ^{238}U at Site 300 is due to the use of "depleted" uranium (a byproduct of ^{235}U enrichment) at the site. As noted, however, the uranium concentrations correspond to less than 0.01% of the Concentration Guides of AEC Manual Chapter 0524.

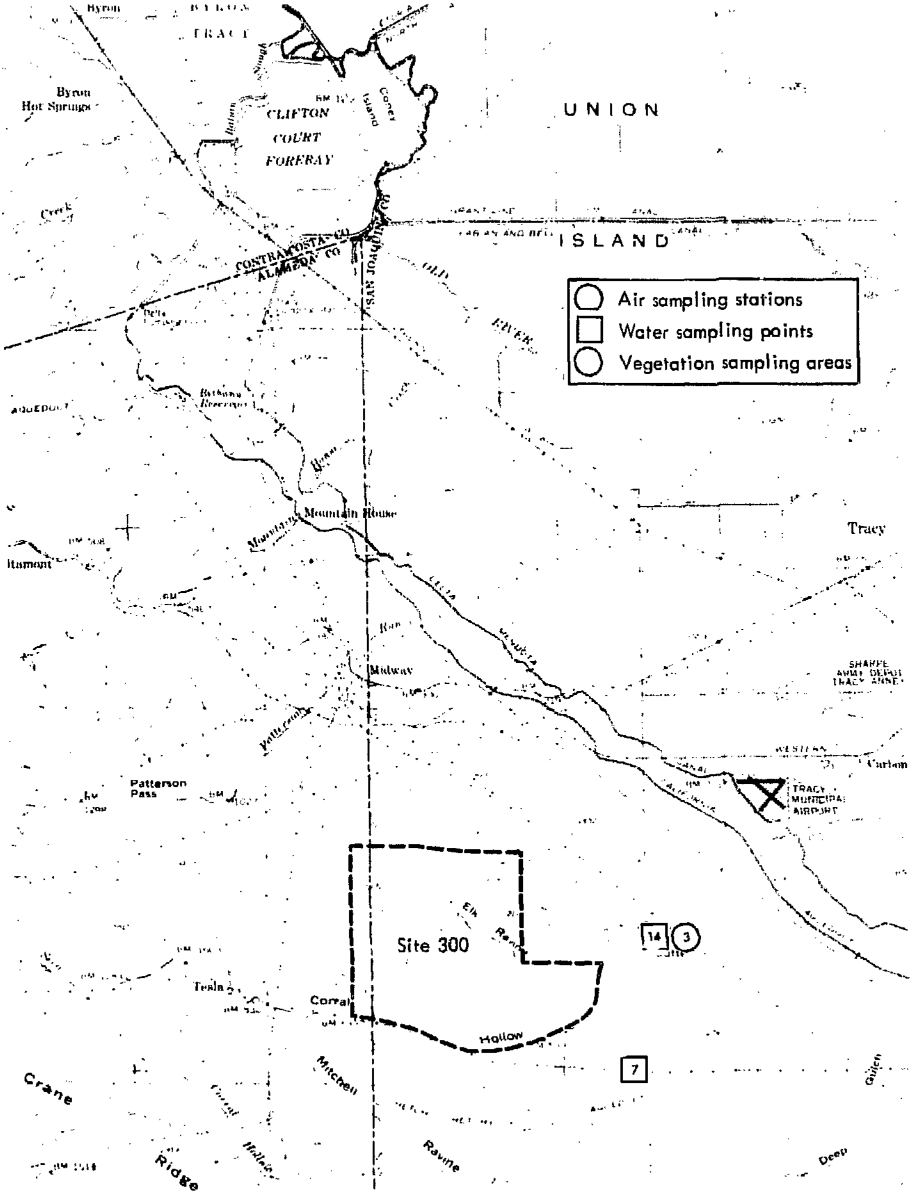


Fig. 4. Air, water and vegetation sampling locations in the Site 300 area.

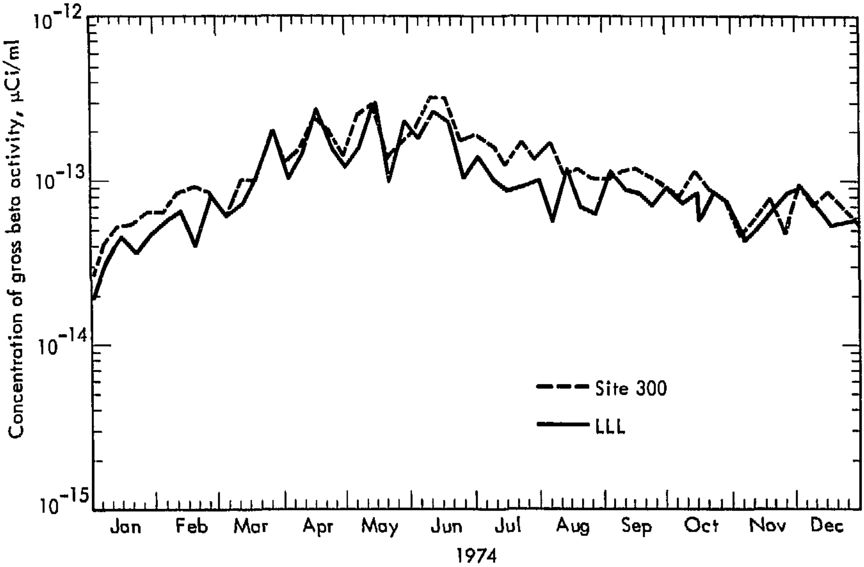


Fig. 5. Weekly average gross beta activity on air filters from Livermore Valley and Site 300 sampling locations.

Airborne tritiated water (HTO) concentrations were determined at each of the LLL perimeter sampling locations shown in Fig. 1. Water vapor was collected on silica gel samplers operated at about 0.5 litre/min for 1-week periods. The collected water was recovered by vacuum-drying at 150°C, and the HTO was measured by liquid scintillation counting. Table 7 shows maximum, minimum, and average concentrations observed at each location. The annual average concentration for the set is 4.7×10^{-11} µCi/ml which is comparable to the 3.9×10^{-11} µCi/ml average for the same sampling locations during 1973. The maximum weekly HTO concentration of 8.5×10^{-10} µCi/ml, observed at Location 12 (Fig. 1), is less than 0.5% of the Concentration Guide (CG) of 2×10^{-7} µCi/ml specified by AEC Manual Chapter 0524.

Radioactivity in Soil

An intensive soil sampling program in 1971 and 1972 provided a data base for the concentration range of various radionuclides in soils in the vicinity of the Laboratory and at Site 300. These measurements included naturally occurring radionuclides and those deposited as a result of global fallout, as well as radionuclides from possible Laboratory effluents. In 1973 and 1974, soil sampling in the vicinity of LLL and at Site 300 has been reduced to a continuing surveillance program. Locations are resampled annually to document any changes in environmental levels of radioactivity that may have occurred during the year, and to evaluate any increase that might be due to Laboratory operations. These samples are collected to a depth of 1 cm, and comprise five separate 15-cm-diam (6-in.) samples at each location.

All samples were dried, ground, and blended. For radiochemical analysis, 100-g aliquots were completely dissolved and ^{239}Pu and ^{238}Pu were determined using standard radiochemical techniques. For gamma spectra analysis, approximately 300-g aliquots of soil were sealed in 200-cm^3, thin-walled aluminum cans and counted in the Ge(Li) spectrometer previously referenced.[1]

A number of on-site soil samples were collected and analyzed as part of a special study of the radiological background characteristics of the Livermore site. Figure 6 shows the location of these samples, and Table 8 shows the data obtained. Higher levels of plutonium and americium east of the waste disposal area are due to

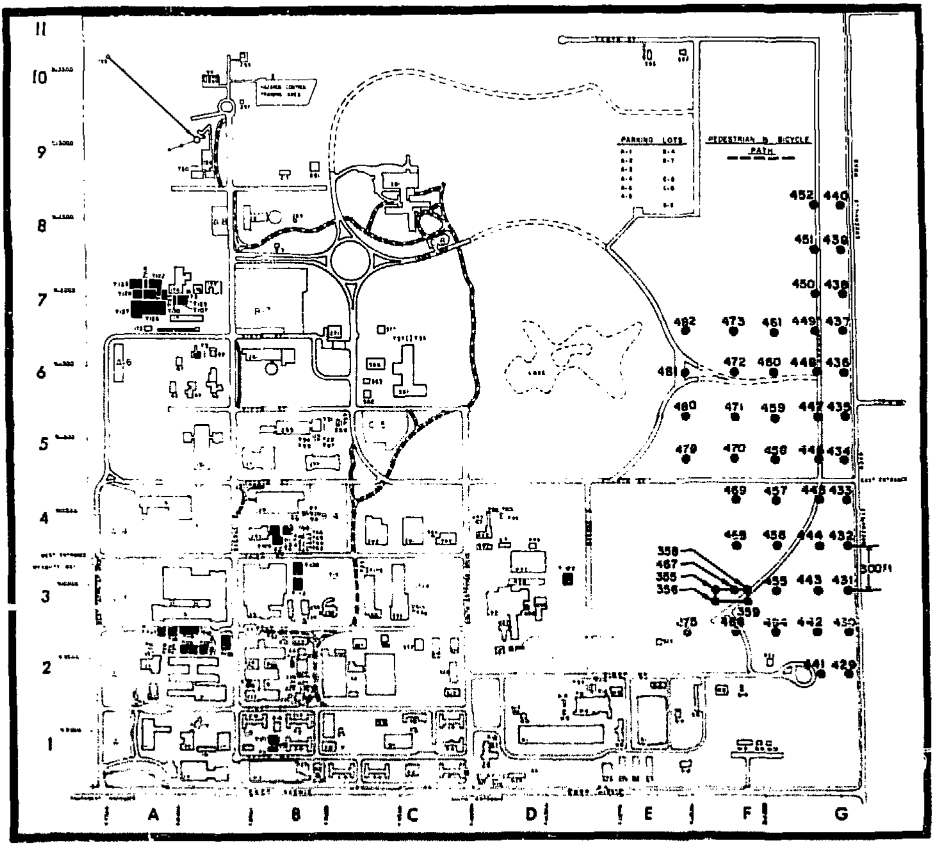


Fig. 6. Locations of soil samples collected on-site at Lawrence Livermore Laboratory.

accumulated effects of waste disposal activities in the area over the past several years.

Figure 7 shows the location of off-site samples collected east of Greenville Road. Table 9 compares the plutonium levels in soil samples in 1974 with those collected in the same areas during 1973. No increases in ^{239}Pu were observed over the levels reported in 1973. Figure 8 locates soil sampling areas within Site 300. High-explosive tests at Site 300 often involve the use of depleted uranium. Accordingly, soil samples are taken annually to determine the extent to which the natural $^{235}U/^{238}U$ ratio of the soil is perturbed by these operations. To date the analyses have indicated that isotopic perturbation is essentially restricted to areas adjacent to the firing bunkers.[5] Prior to 1974, these ^{235}U and ^{238}U measurements have been based on mass spectrometry. However, the 1974 data have been obtained by gamma spectrometry. Gamma-ray measurement of ^{238}U in soil generally relies on the gamma emission from ^{226}Ra daughters in the

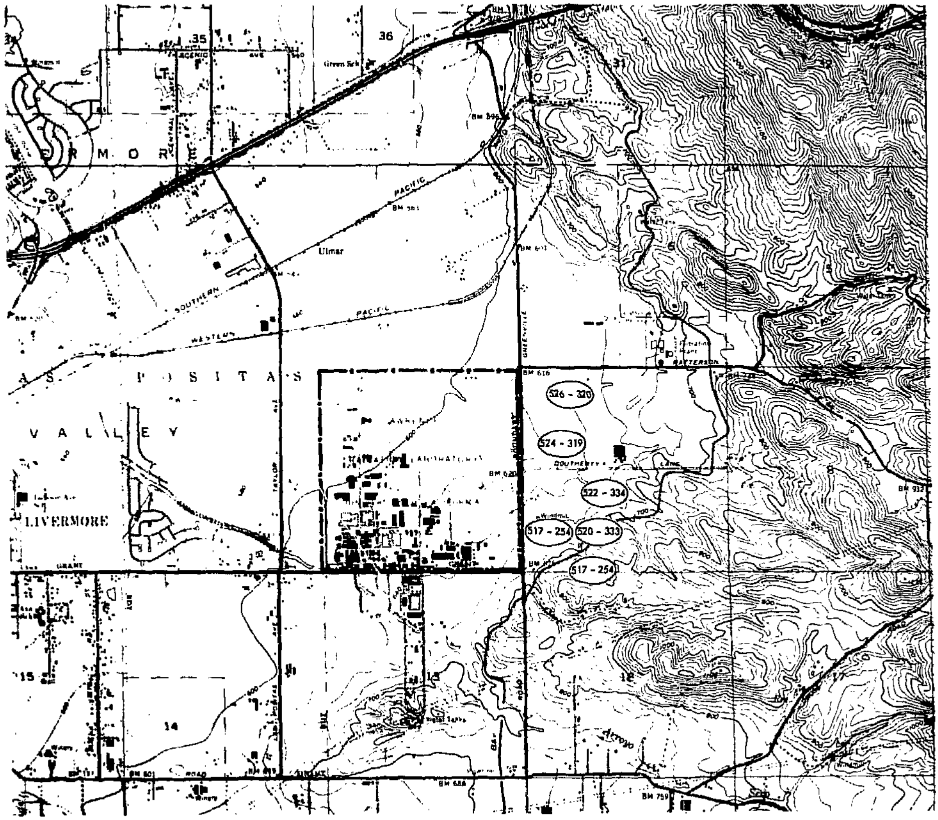


Fig. 7. Locations of soil samples collected in the vicinity of Lawrence Livermore Laboratory.

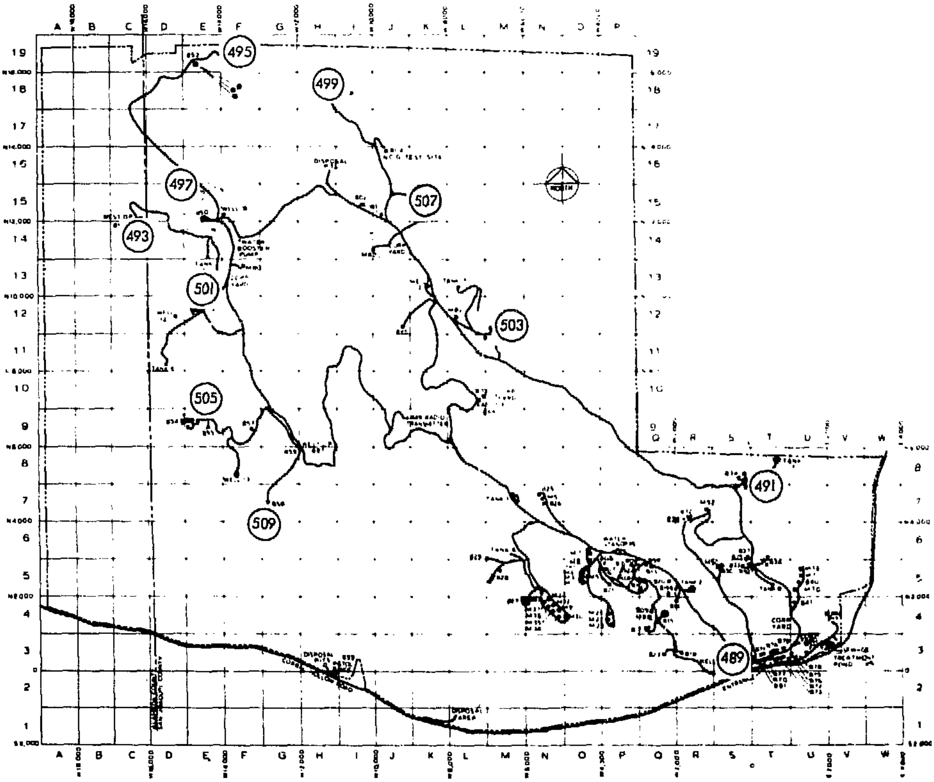


Fig. 8. Locations of soil samples collected inside Site 300 boundary.

uranium decay scheme, with the assumption that ^{238}U is in secular equilibrium with its daughters. These decay products are essentially absent in "depleted" uranium. A direct measurement of ^{238}U was employed using the 63-keV transition gamma from ^{234}Th, the first daughter of ^{238}U.[6] This technique does not depend on uranium-radium equilibrium; it has the additional advantage that the ^{235}U and ^{238}U data are obtained simultaneously with the measurement of other gamma-emitting radionuclides in soil. The isotopic uranium data, shown in Table 10, are comparable to those observed during 1973. Plutonium and ^{137}Cs levels are in the range expected from global fallout.

Radioactivity in Sewage

Liquid radioactive wastes are treated to reduce activity levels to as low as practicable and well below standards set by AEC Manual Chapter 0524. Following this treatment, the liquid waste is released to the City of Livermore's sanitary sewer system at the LLL outfall shown in Fig. 1.

This effluent is continuously monitored for pH and radioactivity.

The Livermore water reclamation plant is a 200-ℓ/s (5 000 000 gal/day) secondary sewage plant serving the residential, commercial, and industrial users in Livermore. Sanitary sewage from LLL contributes about 13 ℓ/s (300 000 gal/day), which is about 6% of the total capacity of the plant. Sewage entering the plant flows into the primary settling tanks where most solids drop out and grease floats to the surface. Next, the sewage is pumped over two trickling filter units where aerobic bacteria growing on filter rock oxidize organic matter in the sewage. The sewage then enters an activated sludge aeration tank where microbes suspended in the sewage further oxidize organics to purify the waste. After aeration, the sewage flows to the final sedimentation tank where the suspended microbes settle out. The purified sewage is chlorinated to kill pathogenic bacteria before release from the plant since the treated waste is used to recharge ground-water supplies. Treated water (the plant effluent) is used for irrigating the Livermore Municipal Golf Course, lawns of the Livermore Airport, and nearby agricultural land; the excess is discharged into Arroyo Las Positas.

Solids from the settling tanks are pumped to anaerobic digesters where bacteria break down the organics to yield stablized sludge and methane. This sludge is then pumped into one of two large lagoons. During the summer, a portion of this sludge is removed to drying beds. The dried sludge is available to the public for use as a soil conditioner.

Weekly samples are collected from each digester, the aeration tank, and the liquid effluent. Gross alpha and beta activities, as well as specific alpha-emitting radionuclides, are measured in monthly composites of the weekly samples to determine if any significant buildup of radioactivity occurs within the plant. In addition, the activity levels of certain radionuclides in the LLL effluent are compared with those in the effluent from the Livermore treatment plant. These data are shown in Tables 11 through 13. It is seen that most of the activity is associated with the solids (sludge) in the plant.

Radioactivity in Water

Water samples are collected from various locations in the Livermore Valley and at Site 300 as shown in Figs. 1 through 4. Samples are evaporated and the residues are transferred to counting planchets with dilute nitric acid. After flaming, the planchets are counted for gross alpha and beta activities in a gas proportional counter. There were no samples with an alpha activity above the minimum detection limit of 1.2×10^{-9} µCi/ml. The gross beta activities for the Livermore Valley samples are listed in Table 14. Locations 11, 15 through 17 and 21 through 24 are surface sources such as ponds, creeks, and reservoirs. Livermore rainfall is sampled at Location 20. The balance are domestic water sources. Annual average gross beta activities in Livermore waters in 1974 were about 50% higher than they were in 1973. This increase is probably due to the increased beta activity in ground-level air present in 1974. Gross beta activities in Site 300 water samples are shown in Table 15. These samples are collected from on-site wells supplying Site 300 (Locations 1 through 7) and off-site creek sources (Locations 11 and 14). The Location 20 represents Site 300 rainwater. The remainder are on-site ponds or springs. Annual average gross beta activity of Site 300 water during 1974 was essentially unchanged from 1973. With the exception of rainwater and the two off-site creek sources, the Site 300 samples came primarily from deep wells and springs. Accordingly, the increased airborne beta activity had little effect on them.

These samples are also analyzed for tritium activity. Because of the low activities, it was necessary to distill and electrolytically enrich the samples prior to liquid scintillation counting. Tables 16 and 17 show the data for Livermore and Site 300 samples, respectively. Inspection of the data indicates that the samples exhibit rather uniform tritium concentrations that are well below the recommended concentration guide value. The tables also include an estimate of the annual dose that may be delivered to an adult consuming water containing the listed tritium concentrations. The doses, which are typically less than 0.1 mrem, are based upon a daily water consumption of 1 litre/day and the model of Anspaugh et al.[7]

Radioactivity in Vegetation

Vegetation samples (usually native grasses) are collected at monthly intervals throughout the Livermore Valley, at Site 300, and in the off-site vicinity of Site 300 at the locations shown in Figs. 2, 3, and 4. These samples are freeze-dried and the tritium activity in the recovered water is determined by liquid scintillation counting. Table 18 shows the tritium data on vegetation collected in the Livermore Valley. The data indicate generally higher tritium concentration east and north of the Laboratory, which would be expected since the prevailing winds are from the west and southwest. The whole-body radiation doses shown in the table were derived from the model of Anspaugh et al.,[7] assuming that the observed activities were typical of edible vegetation grown in this area. The possible doses, which are less than 1 mrem per year, are based upon the direct daily consumption of 400 g of vegetation,[8] normally 80% water.

Table 19 shows the tritium data for Site 300. With the exception of Locations 6 and 13, the tritium levels of Site 300 vegetation are lower and show less fluctuation than do the Livermore Valley samples. Location 6 is adjacent to an area containing tritium-contaminated debris from a firing table. Under the influence of seasonal rains, the tritium has apparently entered an aquifer whose outflow is in the area where Sample 13 is routinely collected.

Radioactivity in Milk

The only dairy in the general vicinity of Laboratory operations is located about 10 km (6 mi) southwest of Tracy. Periodic milk samples are collected from the dairy throughout the year. Before analysis, the samples are concentrated by means of freeze-drying and the concentrates are gamma-counted in a Ge(Li) counting system. In addition, each sample is analyzed for tritium activity by counting the water recovered from freeze-drying in a liquid scintillation counting system. Activities of ^{137}Cs, ^{40}K, and ^{3}H are shown in Table 20. No other radionuclides were detected. Also shown are the calculated annual adult whole-body or critical organ radiation dose

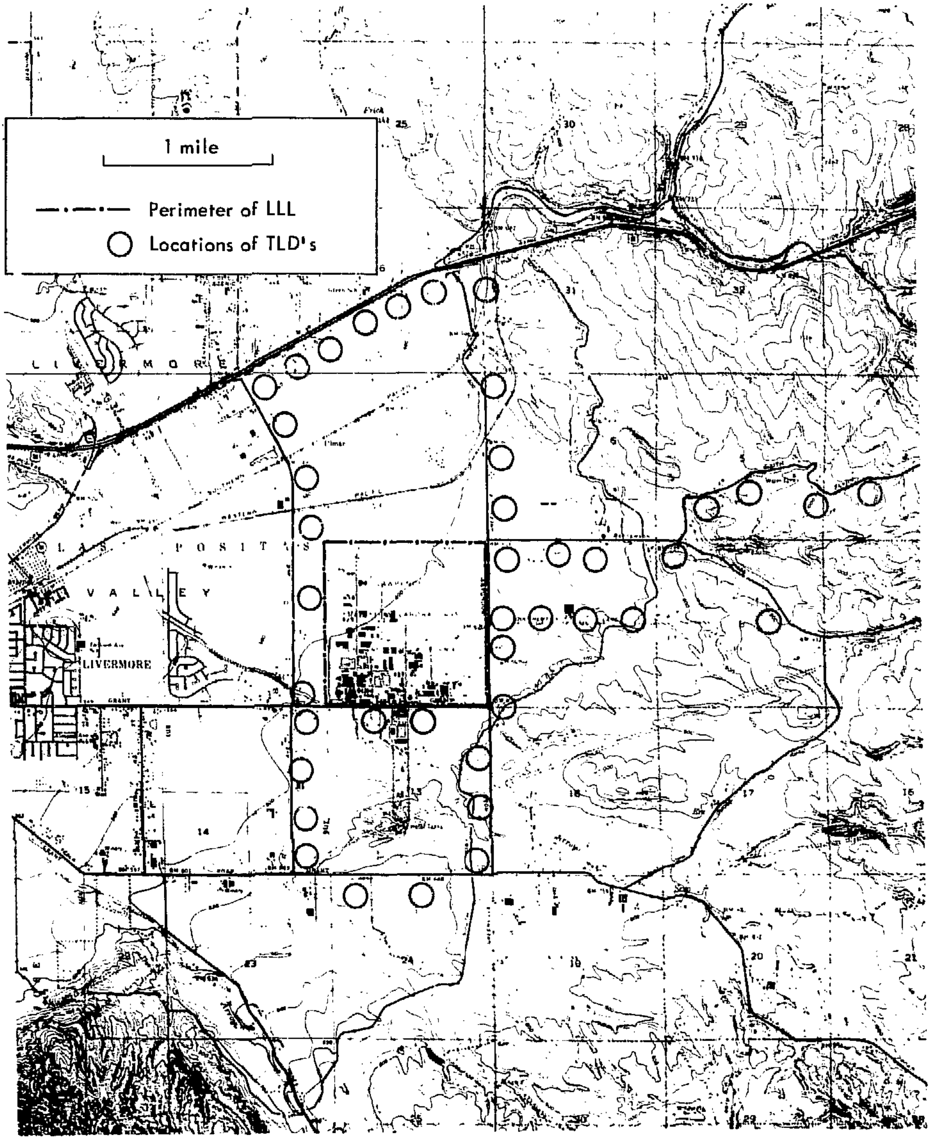


Fig. 9. Location of thermoluminescent dosimeters in the vicinity of the Lawrence Livermore Laboratory.

delivered to man via the milk pathway. These calculations are based on a daily intake of 260 g/day and the models previously referenced. As expected, the only dose to an individual above 1 mrem is that from naturally occurring ^{40}K.

Environmental Radiation Measurements

Environmental radiation measurements are made at 12 LLL perimeter locations shown on Fig. 1, and at 41 off-site locations shown in Fig. 9, in the vicinity of the Laboratory. These measurements are obtained from CaF_2: Dy (TLD-200) thermoluminescence dosimeters placed at a height of approximately 1 m above the ground. Exposure periods are 3 months. Based on past measurements,[9] the environmental terrestrial exposure rates in the Livermore Valley vary between 3 and 7 μR/hr; cosmic radiation, calculated from the local elevation and geomagnetic latitude according to the data of Lowder and Beck,[10] is approximately 4 μR/hr. Table 21 shows quarterly and annual doses in millirem derived from the measured exposure rates at perimeter locations. The elevated dose rate at Location 5 is from an accelerator facility adjacent to the south site boundary. This dose rate represents an increase over 1973, and was due to programmatic requirements for operation of a 14-MeV neutron generator at higher flux rates. Means of reducing this dose rate are being investigated. Figure 10 shows an annual frequency distribution of environmental dose rates observed at the 41 off-site locations. The single dosimeter which recorded the high (210-215 mrem) dose is near an off-site industrial plant where radiography is frequently performed. The average off-site dose rate of 68 mrem is comparable to the 71 mrem observed during 1973. The average perimeter dose rate was 74 mrem, compared with 75 mrem observed for 1973.

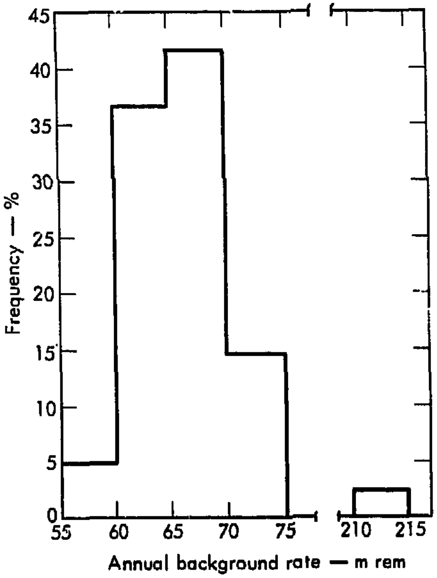
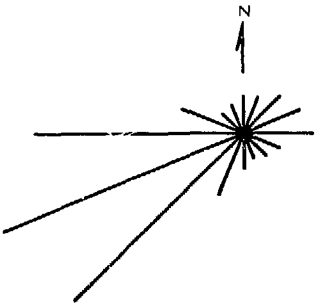


Fig. 10. Annual off-site radiation background, in millirem, measured during 1974.

NON-RADIOACTIVE MONITORING

Airborne Beryllium

Beryllium monitoring, both of in-plant air and at or near the property boundaries, has always been a part of the LLL safety program. Each month half of each LLL perimeter and Site 300 filter is composited by sampling location, wet-digested, and the beryllium content of the solutions determined by atomic absorption analysis. Beryllium analyses based on air filtration requires an easily dissolved filter having



Wind rose shows relative frequency of wind direction (by the length of the line) obtained from the tabulated annual data below

Frequency of Wind In Percent for Livermore — 1971

Mo.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
Jan	2.7	2.2	7.2	12.1	17.8	6.8	6.2	2.2	3.9	3.8	4.9	7.0	9.7	7.6	2.0	2.6	1.3
Feb	2.2	2.5	6.9	12.9	14.8	7.2	5.1	2.8	3.5	3.0	4.9	8.0	11.2	8.5	3.4	2.0	1.4
Mar	2.1	2.2	6.4	12.3	13.5	6.9	4.9	2.7	3.3	2.6	4.6	10.5	12.2	9.1	3.1	1.8	1.7
April	2.1	2.3	4.6	8.7	9.4	5.1	3.2	2.1	3.0	4.8	10.8	16.1	13.9	7.4	2.2	1.8	2.3
May	2.2	1.9	3.8	6.5	7.1	4.0	2.4	1.7	2.4	4.7	15.3	17.7	16.7	6.0	1.9	1.9	3.8
June	2.1	1.7	3.4	5.6	6.2	3.5	2.1	1.4	2.2	4.6	16.9	19.8	17.7	5.4	1.7	1.6	3.9
July	1.7	1.4	2.8	4.6	5.1	2.9	1.8	1.3	2.0	5.3	19.5	22.9	17.2	4.6	1.4	1.4	4.0
Aug	1.6	1.4	2.7	4.5	5.0	2.8	1.7	1.3	2.1	5.3	19.8	23.5	17.0	4.5	1.4	1.4	4.1
Sept	1.9	1.4	2.5	4.0	4.4	2.5	1.6	1.3	2.2	5.4	21.1	23.3	17.3	4.7	1.4	1.2	3.7
Oct	2.4	1.6	2.7	4.1	4.5	2.7	1.6	1.3	2.2	5.7	20.6	22.5	16.3	4.6	1.5	2.2	3.5
Nov	2.6	2.5	3.4	4.5	4.9	2.7	1.9	1.9	2.6	5.4	19.2	20.5	15.5	4.7	2.0	2.3	3.3
Dec	2.8	3.0	3.9	4.6	5.3	3.0	2.6	2.2	2.7	5.1	17.7	19.2	15.3	4.8	2.1	2.4	3.1
Annual Average	2.2	2.0	4.2	7.0	8.2	4.2	2.9	1.8	2.7	4.7	14.6	17.6	15.0	6.0	2.0	1.9	3.0

Fig. 11. Typical annual average wind pattern for Livermore, California (LLL data — 1971).

a low trace metal background. These requirements are met by Whatman 41, and this is the reason for its continued use at LLL.

Tables 22 and 23 show monthly average airborne beryllium concentrations for LLL perimeter and Site 300 sampling locations, respectively. There appears to be no difference between the levels at Site 300, where beryllium is frequently expended in high-explosive experiments, and those observed at Livermore. The concentrations, which are 3 to 4 orders of magnitude below the emission standard, can be accounted for by resuspension of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 ppm of beryllium. Livermore's air typically contains 10-100 μg of particulates per cubic metre. Using a value of 50 $\mu g/m^3$ for an average dust load and 1 ppm for the beryllium content of this dust would give an airborne beryllium concentration of 5.0×10^{-5} $\mu g/m^3$, in agreement with the data in the tables. These concentrations are highest during the dry

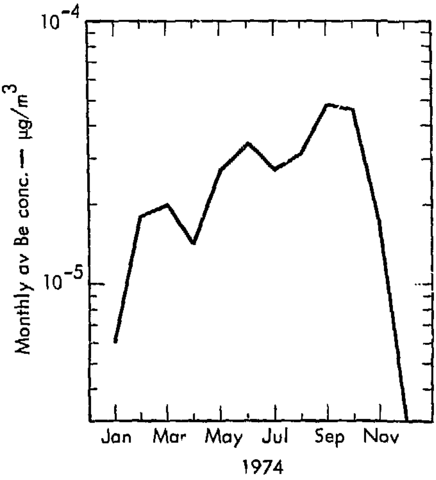


Fig. 12. Concentration of beryllium in LLL site perimeter air filters during 1974.

dusty summers and are lowest during the winter rainy season as shown in Figs. 11 and 12.

Heavy Metals Released to Livermore Sanitary Sewer

As noted in the previous section, sanitary sewage from the Laboratory is treated at the Livermore Municipal Water Reclamation Plant, a 200 ℓ/sec (5 000 000 gal/day) secondary sewage plant serving the residential, commercial, and industrial users in Livermore. The LLL sewage effluent is continuously monitored for pH and radioactivity prior to entering the Livermore system.[11] In addition, composites of sewage representative of daily flow are collected and analyzed for copper and chromium using atomic absorption analyses. These daily samples are also composited on a weekly basis and analyzed for the balance of metals shown in Table 24. The data in this table, however, represent monthly averages based on these weekly measurements. These concentrations meet the requirements for discharges of industrial wastes specified by the City of Livermore (see Appendix A).

Physical and Chemical Analysis of LLL Sewage

A 24-hr sample of Laboratory sewage effluent is collected at periodic intervals. These samples are subjected to a variety of analyses including biochemical oxygen demand, ammonia, nitrate, and total nitrogen content, alkalinity, and total solids. After treatment at the Livermore water reclamation plant, the water may be used for irrigation. Accordingly, the boron analysis is made because this element influences water uptake by the soil. Table 25 shows typical data for 1974 which meet the discharge requirements of the Livermore City Code Section 18.63 (see Appendix A).

ENVIRONMENTAL IMPACT OF LLL EFFLUENTS

Radioactive Airborne Effluents

During 1974 an estimated 680 Ci of ^{41}Ar were released by the 3-MW pool-type reactor, 1900 Ci of tritium by combined Laboratory sources, and the linear accelerator released a total of 1300 Ci of $^{15}O_2$-$^{13}N_2$. With the exception of tritium, all these radionuclides are short-lived. Comparative releases in 1973 were 1300 Ci of ^{41}Ar, 2500 Ci of tritium, and 720 Ci of $^{15}O_2$-$^{13}N_2$. A reduced operating schedule for the reactor and the use of a neutron-absorbing paint (gadolinium) in the east thermal column was responsible for the decrease in ^{41}Ar. The increase in air activation was the result of increased underground operation at the linear accelerator. Table 26 shows the estimated radiation dose to the public from the 1974 effluents. The following three dose reference points were employed: (1) the "fence post" dose at the location on the site boundary where the maximum exposure rates exist, (2) dose to nearest resident, and (3) the man-rem dose within a radius of 80 km (50 mi). The meteorological diffusion model used in calculating these doses is based on the model suggested by Pasquill and modified by Gifford.[12] Source terms for those calculations were based on data from continuously operating stack monitoring equipment. Tritium doses are conservative, since it is assumed that all tritium is in the form of tritiated water. The difference in man-rem doses between wet and dry seasons is due to difference in prevailing wind direction during these periods and is not related to "rainout." At Livermore, the wet season normally extends from November through April. Figure 13 shows that, while the annual average winds are predominantly from the southwest, the wet-season winds tend to be reversed. Since population is not distributed uniformly, there are accompanying seasonal man-rem dose differences.

Radioactive Liquid Effluents

Except for low-level radioactive liquid wastes which are discharged to the Livermore sanitary sewers, LLL does not release radioactive liquids to the environment. During 1974, the principal radionuclides released to the sewer were 1.2×10^{-4} Ci of ^{239}Pu and 16 Ci of HTO. Table 13 shows the concentration of these radionuclides in the treated effluent from the Livermore Sewage Treatment Plant to be 7.9×10^{-12} and 6.0×10^{-6} µCi/ml for ^{239}Pu and HTO respectively. These concentrations represent 2.6×10^{-5}% and 0.2% of the AEC Manual Chapter 0524 drinking water standard for ^{239}Pu and HTO, respectively. In addition, during 1974 the average annual gross beta activity of the LLL sewage effluent was 6.2×10^{-8} µCi/ml. It is assumed that this activity is due to beta-gamma emitters, which are released to the sewer system in accordance with AEC Manual Chapter 0524. Analysis of samples collected at the point of discharge show the presence of ^{134}Cs, ^{137}Cs, ^{65}Zn, ^{56}Mn, ^{60}Co, ^{95}Zr, ^{95}Nb, ^{125}Sb, and ^{110}Ag. Even if any of these radionuclides were assumed to be the sole source of the 6.2×10^{-8} µCi/ml, Table 27 shows that none would account for over 1% of the CG of AEC Manual Chapter 0524.

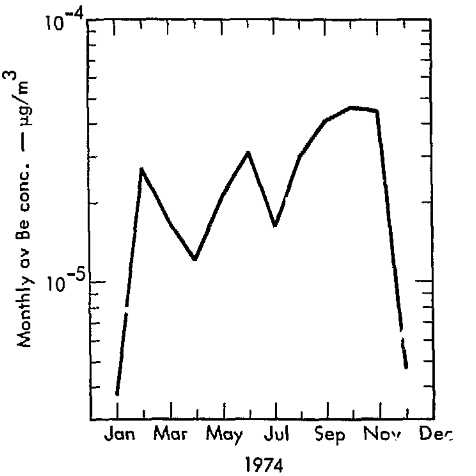


Fig. 13. Concentration of beryllium in Site 300 air filters during 1974.

Site 300 Ecology Impact Study

As part of our ongoing LLL program of environmental surveillance, an ecology study was made at Site 300 in 1974 to determine if LLL operations have had a measurable impact on plants and animals native to the area. The ecosystem is dominated by perennial grasslands which are grazed by cattle, sheep, and deer. Small rodents abound which are preyed upon by snakes, raptors, and a variety of carnivorous mammals. The study involved collection of plants and animals in the vicinity of the high-explosive firing bunkers. Similar sample groups were collected about 10 km (6 mi) west of the site. This direction (normally upwind) and distance gave reasonable assurance that these samples would represent background conditions unaffected by LLL operations.

Animals were dissected and individual organs were freeze-dried. Free-water tritium was determined on the recovered water and tissue-bound tritium was determined by burning a portion of the freeze-dried material in an oxygen bomb. Tritium measurements were made by internal gas counting. Tritium was determined in the same manner employed for plant tissues. Freeze-dried animal sections (organs, bones, muscle, feces) were dissolved and uranium isotopes were determined by mass spectrometry. Beryllium was determined by atomic absorption analysis.

Analysis of the data showed that while tritium, beryllium, and uranium were present in some plants and animals, in general the levels measured in the biota on Site 300 were not significantly different from those found in organisms obtained from environmental areas of similar ecology.

Uptake of Radioactivity and Trace Metals by Vegetables Grown in Livermore Treatment Plant Sludge

The Laboratory routinely releases small quantities of trace elements and radionuclides to the Livermore sewer system in accordance with appropriate standards. At the Livermore Waste Water Treatment Plant these tend to separate with the digested sludge. This sludge is available to the public for use as a soil conditioner. A study was conducted at LLL during 1974 to determine the uptake of these elements by edible crops grown in soil treated with sludge.

Sludge was applied 7 cm thick to an experimental garden plot 10 metres by 15 metres. Soil was mixed to 14 cm with a rototiller, giving a 50% sludge mix. A control plot of similar dimensions but with no added soil conditioner or fertilizer was also established. A variety of plants and seeds were planted that would produce root, stem, leaf, flower, fruit, and seed parts that could be analyzed for uptake of the several elements of interest.

Trace-element content was determined principally by atomic absorption and neutron activation. Radioisotopes were determined through use of low-background gamma spectrometry for gamma emitters, alpha pulse-height spectrometry for plutonium, and standard radiochemical techniques for strontium-90.

Principal Findings of the Study

1. Radioisotopes — The sludge contained only five radioisotopes above background levels, namely ^{60}Co, ^{65}An, ^{125}Sb, ^{137}Cs, and ^{239}Pu. Few of the plants picked up these radioisotopes in measurable quantities.

Broccoli grown in the sludge garden contained ten times as much ^{137}Cs as did broccoli grown in the control garden. Similarly, plutonium levels in sludge-grown turnips and broccoli were double the level found in the control plants. The apparent plant discrimination factor for plutonium uptake by the turnips and broccoli varied from 9×10^{-5} to 2×10^{-4}, respectively. None of the radioisotopes were concentrated in the plants to levels constituting a hazard to persons eating the vegetables as part of their diet. For example, considering this low plutonium uptake, a person eating vegetables grown in soil conditioned with the sludge would receive a 50-year total integrated dose of less than 1 mrem, considerably less than the allowed 50-year dose of 25 rem for a non-radiation worker.

2. Trace Elements — Zinc and cadmium levels in the sludge soil were 15 to 75 times higher than those in the control soil. Freeze-dried lettuce and radish leaves from plants grown in sludge soils contained Zn and Cd levels equal to those in the soil. Although the strontium levels in the sludge soil and control soil were about equal, strontium uptake was much higher in control-grown plants than in those grown in the sludge garden. The calcium content of the sludge soil was higher than in the control, and the plants may have reached their capacity for divalent alkaline earth ions with calcium. Copper levels in the sludge soil were 20 times higher than in the control soil, but plants grown in the sludge soil showed no higher copper uptake. Chromium uptake was also negligible. Finally, seeds showed very little concentration of trace elements, while leaves generally were quite responsive to change in trace metal content of the soil.

Table 1. Gross beta in air filters from Livermore Valley during 1974 (μCi/ml).

Location[a]	January-June				July-December				Annual average	% CG[b]
	No. of samples	Maximum	Minimum	Average	No. of samples	Maximum	Minimum	Average		
1	25	$2.8 \times 10^{-13} \pm 2.0\%$	$2.3 \times 10^{-14} \pm 6.0\%$	1.2×10^{-13}	25	$7.0 \times 10^{-13} \pm 1.0\%$	$3.7 \times 10^{-14} \pm 6.6\%$	9.8×10^{-14}	1.1×10^{-13}	11
2	25	$2.9 \times 10^{-13} \pm 2.0\%$	$2.6 \times 10^{-14} \pm 7.0\%$	1.3×10^{-13}	24	$1.1 \times 10^{-13} \pm 1.0\%$	$3.2 \times 10^{-14} \pm 5.0\%$	6.8×10^{-14}	9.7×10^{-14}	10
3	25	$1.8 \times 10^{-13} \pm 4.0\%$	$1.1 \times 10^{-14} \pm 23.0\%$	8.8×10^{-14}	20	$9.2 \times 10^{-14} \pm 7.0\%$	$6.6 \times 10^{-15} \pm 14.4\%$	4.9×10^{-14}	6.6×10^{-14}	7
4	22	$4.7 \times 10^{-13} \pm 2.0\%$	$7.9 \times 10^{-15} \pm 6.0\%$	1.9×10^{-13}	22	$5.3 \times 10^{-13} \pm 4.0\%$	$3.2 \times 10^{-15} \pm 100.0\%$	1.3×10^{-13}	1.6×10^{-13}	16
5	26	$2.3 \times 10^{-13} \pm 3.0\%$	$9.0 \times 10^{-16} \pm 19.0\%$	9.6×10^{-14}	24	$1.1 \times 10^{-13} \pm 5.0\%$	$4.0 \times 10^{-14} \pm 9.4\%$	6.5×10^{-14}	8.2×10^{-14}	8
6	23	$2.0 \times 10^{-13} \pm 4.0\%$	$2.5 \times 10^{-14} \pm 10.0\%$	9.5×10^{-14}	20	$1.0 \times 10^{-13} \pm 6.0\%$	$2.0 \times 10^{-14} \pm 8.0\%$	5.4×10^{-14}	7.6×10^{-14}	8
7	22	$4.1 \times 10^{-13} \pm 2.0\%$	$1.9 \times 10^{-14} \pm 16.0\%$	1.5×10^{-13}	20	$1.1 \times 10^{-13} \pm 4.6\%$	$2.9 \times 10^{-14} \pm$ 10.[illegible]%	7.3×10^{-14}	1.1×10^{-13}	11
8	23	$2.1 \times 10^{-13} \pm 4.0\%$	$2.4 \times 10^{-14} \pm 10.0\%$	9.8×10^{-14}	25	$9.7 \times 10^{-14} \pm 7.0\%$	$1.7 \times 10^{-14} \pm 13.0\%$	5.1×10^{-14}	7.4×10^{-14}	7
9	19	$5.2 \times 10^{-13} \pm 2.8\%$	$6.3 \times 10^{-14} \pm 7.0\%$	2.4×10^{-13}	18	$2.3 \times 10^{-13} \pm 4.0\%$	$6.5 \times 10^{-14} \pm 5.9\%$	1.3×10^{-13}	1.9×10^{-13}	19
10	25	$2.3 \times 10^{-13} \pm 4.2\%$	$1.6 \times 10^{-14} \pm 44.0\%$	9.6×10^{-14}	26	$1.0 \times 10^{-13} \pm 7.0\%$	$5.8 \times 10^{-16} \pm 7.0\%$	5.5×10^{-14}	7.5×10^{-14}	8
11	24	$2.2 \times 10^{-13} \pm 4.0\%$	$2.1 \times 10^{-14} \pm 39.0\%$	9.1×10^{-14}	22	$4.8 \times 10^{-13} \pm 6.6\%$	$3.7 \times 10^{-14} \pm 9.4\%$	8.0×10^{-14}	8.6×10^{-14}	9
12	26	$3.2 \times 10^{-13} \pm 2.0\%$	$4.4 \times 10^{-16} \pm 3.0\%$	1.3×10^{-13}	27	$1.2 \times 10^{-13} \pm 4.4\%$	$3.9 \times 10^{-16} \pm 3.0\%$	8.6×10^{-14}	1.1×10^{-13}	11
13	25	$2.7 \times 10^{-13} \pm 2.0\%$	$2.5 \times 10^{-14} \pm 6.0\%$	1.1×10^{-13}	24	$5.6 \times 10^{-13} \pm 5.2\%$	$3.8 \times 10^{-14} \pm 6.4\%$	9.2×10^{-14}	1.0×10^{-13}	10
14	26	$2.8 \times 10^{-13} \pm 2.0\%$	$3.5 \times 10^{-16} \pm 3.0\%$	1.2×10^{-13}	26	$3.5 \times 10^{-13} \pm 2.3\%$	$6.7 \times 10^{-16} \pm 3.0\%$	9.1×10^{-14}	1.1×10^{-13}	11
15	26	$1.8 \times 10^{-12} \pm 2.7\%$	$4.2 \times 10^{-16} \pm 7.0\%$	1.8×10^{-13}	25	$1.2 \times 10^{-13} \pm 3.0\%$	$4.1 \times 10^{-14} \pm 6.5\%$	7.6×10^{-14}	1.3×10^{-13}	13
16	24	$2.8 \times 10^{-13} \pm 2.0\%$	$2.0 \times 10^{-14} \pm 4.0\%$	1.3×10^{-13}	21	$2.4 \times 10^{-13} \pm 2.7\%$	$4.6 \times 10^{-14} \pm 6.4\%$	9.7×10^{-14}	1.2×10^{-13}	12
17	23	$4.3 \times 10^{-13} \pm 3.0\%$	$1.7 \times 10^{-14} \pm 4.0\%$	1.6×10^{-13}	20	$1.4 \times 10^{-13} \pm 3.0$	$5.1 \times 10^{-14} \pm 6.2\%$	9.2×10^{-14}	1.3×10^{-13}	13

[a]See Figs. 1 and 2 for sampling locations

[b]Concentration Guide (CG) for gross beta (air) is 1×10^{-12} μCi/ml.

Table 2. Gross beta activity in air filters from Site 300 during 1974 (μCi/ml).

	January-June				July-December					
Location[a]	No. of samples	Maximum	Minimum	Average	No. of samples	Maximum	Minimum	Average	Annual average	% CG[b]
1	28	$2.9 \times 10^{-13} \pm 2.0\%$	$3.$[illegible] $\times 10^{-16} \pm 2.0\%$	1.4×10^{-13}	25	$2.0 \times 10^{-13} \pm 1.0\%$	$4.7 \times 10^{-14} \pm 5.1\%$	1.0×10^{-13}	1.2×10^{-13}	12
2	24	$4.1 \times 10^{-13} \pm 1.0\%$	$2.7 \times 10^{-14} \pm 8.0\%$	1.5×10^{-13}	25	$2.6 \times 10^{-13} \pm 2.0\%$	$5.7 \times 10^{-14} \pm 5.3\%$	1.1×10^{-13}	1.3×10^{-13}	13
3	25	$3.2 \times 10^{-13} \pm 2.0\%$	$2.0 \times 10^{-14} \pm$ [illegible].1%	1.2×10^{-13}	26	$1.9 \times 10^{-13} \pm 2.0\%$	$3.0 \times 10^{-16} \pm 2.0\%$	9.1×10^{-14}	1.1×10^{-13}	11
4	25	$3.8 \times 10^{-13} \pm 5.0\%$	$2.8 \times 10^{-14} \pm 7.0\%$	1.6×10^{-13}	25	$2.5 \times 10^{-13} \pm 2.0\%$	$2.7 \times 10^{-14} \pm 8.2\%$	1.1×10^{-13}	1.3×10^{-13}	13
5	25	$3.4 \times 10^{-13} \pm 2.0\%$	$2.5 \times 10^{-14} \pm 41.7\%$	1.3×10^{-13}	26	$1.9 \times 10^{-13} \pm 2.0\%$	$4.1 \times 10^{-16} \pm 2.0\%$	9.3×10^{-14}	1.1×10^{-13}	11
7	23	$4.0 \times 10^{-13} \pm 2.0\%$	$2.8 \times 10^{-14} \pm 52.3\%$	1.5×10^{-13}	26	$2.2 \times 10^{-13} \pm 2.0\%$	$2.2 \times 10^{-16} \pm 2.0\%$	1.1×10^{-13}	1.3×10^{-13}	13
8	25	$4.6 \times 10^{-13} \pm 1.0\%$	$4.1 \times 10^{-14} \pm 52.3\%$	2.4×10^{-13}	26	$3.6 \times 10^{-13} \pm 2.0\%$	$2.1 \times 10^{-16} \pm 2.0\%$	1.5×10^{-13}	1.9×10^{-13}	19
9	25	$4.1 \times 10^{-13} \pm 2.0\%$	$2.9 \times 10^{-14} \pm 100.0\%$	1.4×10^{-13}	26	$1.8 \times 10^{-13} \pm 3.0\%$	$1.2 \times 10^{-16} \pm 2.0\%$	9.8×10^{-14}	1.2×10^{-13}	12
10	24	$3.1 \times 10^{-13} \pm 1.0\%$	$2.6 \times 10^{-14} \pm 4.0\%$	1.4×10^{-13}	24	$2.0 \times 10^{-13} \pm 3.4\%$	$3.4 \times 10^{-14} \pm 8.0\%$	1.1×10^{-13}	1.3×10^{-13}	13
11	23	$4.2 \times 10^{-13} \pm 1.0\%$	$2.3 \times 10^{-14} \pm 46.1\%$	1.5×10^{-13}	26	$1.6 \times 10^{-13} \pm 3.0\%$	$3.4 \times 10^{-16} \pm 2.0\%$	1.0×10^{-13}	1.2×10^{-13}	12
Annual avg									1.3×10^{-13}	13

[a]See Fig. 3 for sampling locations.

[b]Concentration Guide for gross beta (air) is 1×10^{-12} μCi/ml.

Table 3. Results of gamma-ray spectral measurements of Livermore Laboratory perimeter air filters during 1974 (μCi/ml).

Month	^{144}Ce	^{141}Ce	^{125}Sb	^{7}Be
Jan	7.3×10^{-15} ± 10%	1.5×10^{-15} ± 10%	3.4×10^{-16} ± 18%	7.8×10^{-14} ± 5%
Feb	1.4×10^{-14} ± 4%	1.6×10^{-15} ± 8%	6.8×10^{-16} ± 20%	9.3×10^{-14} ± 2%
Mar	2.9×10^{-14} ± 3%	2.0×10^{-15} ± 6%	1.4×10^{-15} ± 11%	9.6×10^{-14} ± 2%
April	4.0×10^{-14} ± 5%	1.6×10^{-15} ± 9%	2.0×10^{-15} ± 8%	8.6×10^{-14} ± 2%
May	5.3×10^{-14} ± 3%	1.2×10^{-15} ± 25%	2.8×10^{-15} ± 6%	9.1×10^{-14} ± 3%
June	6.4×10^{-14} ± 4%	8.6×10^{-16} ± 20%	3.6×10^{-15} ± 8%	1.1×10^{-13} ± 3%
July	2.6×10^{-14} ± 6%	2.0×10^{-15} ± 11%	1.5×10^{-15} ± 7%	7.7×10^{-14} ± 2%
Aug	1.6×10^{-14} ± 3%	2.2×10^{-15} ± 7%	9.6×10^{-16} ± 10%	9.1×10^{-14} ± 3%
Sept	1.4×10^{-14} ± 4%	3.4×10^{-15} ± 7%	7.8×10^{-16} ± 14%	1.1×10^{-13} ± 2%
Oct	1.3×10^{-14} ± 8%	2.5×10^{-15} ± 7%	8.8×10^{-16} ± 13%	1.6×10^{-13} ± 2%
Nov	8.7×10^{-15} ± 5%	2.1×10^{-15} ± 8%	4.0×10^{-16} ± 29%	6.2×10^{-14} ± 3%
Dec	1.3×10^{-14} ± 4%	2.5×10^{-15} ± 6%	6.2×10^{-16} ± 21%	8.6×10^{-14} ± 2%
Annual avg	2.5×10^{-14}	2.0×10^{-15}	1.1×10^{-15}	9.6×10^{-14}
CG	2×10^{-14}	5×10^{-9}	9×10^{-10}	4×10^{-8}
% CG	1.3×10^{-2}	4×10^{-5}	1.4×10^{-4}	2.4×10^{-4}

Month	^{103}Ru	^{106}Ru	^{137}Cs	^{95}Zr	^{40}K
Jan	3.3×10^{-15} ± 5%	4.1×10^{-15} ± 6%	6.5×10^{-16} ± 6%	7.3×10^{-15} ± 2%	2.3×10^{-14} ± 40%
Feb	1.8×10^{-15} ± 6%	7.3×10^{-15} ± 3%	1.2×10^{-15} ± 4%	3.3×10^{-14} ± 2%	2.7×10^{-14} ± 36%
Mar	5.6×10^{-15} ± 5%	1.6×10^{-14} ± 3%	2.3×10^{-15} ± 5%	1.9×10^{-14} ± 3%	1.9×10^{-14} ± 44%
April	[illegible] ± 3%	2.2×10^{-14} ± 2%	1.4×10^{-15} ± 3%	2.0×10^{-14} ± 4%	1.9×10^{-14} ± [illegible]
May	1.7×10^{-15} ± 4%	2.8×10^{-14} ± 3%	[illegible] ± 4%	2.0×10^{-14} ± 2%	4.2×10^{-14} ± 30%
June	2.9×10^{-15} ± 11%	1.4×10^{-14} ± 3%	6.2×10^{-15} ± 4%	1.9×10^{-14} ± 2%	1.9×10^{-14} ± [illegible]
July	2.4×10^{-15} ± 7%	1.4×10^{-14} ± 5%	2.7×10^{-15} ± 4%	7.4×10^{-14} ± 5%	3.4×10^{-14} ± 40%
Aug	2.0×10^{-15} ± 3%	9.5×10^{-15} ± 4%	1.8×10^{-15} ± 6%	4.3×10^{-15} ± 4%	3.2×10^{-14} ± 46%
Sept	2.7×10^{-15} ± 10%	7.3×10^{-15} ± 6%	1.6×10^{-15} ± 5%	1.3×10^{-14} ± 4%	1.0×10^{-13} ± 32%
Oct	2.7×10^{-15} ± 4%	6.8×10^{-15} ± 6%	1.4×10^{-15} ± 5%	4.6×10^{-15} ± 3%	9.4×10^{-16} ± 26%
Nov	2.6×10^{-15} ± 6%	4.2×10^{-15} ± 9%	9.4×10^{-16} ± 7%	6.3×10^{-15} ± 4%	[illegible] ± 40%
Dec	3.4×10^{-15} ± 4%	3.4×10^{-15} ± [illegible]	3.3×10^{-15} ± 7%	1.2×10^{-14} ± 2%	2.2×10^{-16} ± 100%
Annual avg	1.4×10^{-15}	1.1×10^{-14}	2.4×10^{-15}	1.2×10^{-14}	3.3×10^{-16}
CG	1×10^{-9}	2×10^{-10}	5×10^{-10}	1×10^{-9}	4.0×10^{-9}
% CG	1.2×10^{-4}	5.5×10^{-3}	4.8×10^{-4}	1.2×10^{-3}	[illegible]

Table 4. Results of gamma-ray spectral measurements of Site 300 air filters during 1974 (μCi/ml).

Month	^{144}Ce	^{141}Ce	^{125}Sb	^{7}Be
Jan	1.1×10^{-16} ± 13%	2.1×10^{-15} ± 8%	4.9×10^{-16} ± 17%	9.5×10^{-14} ± 5%
Feb	1.6×10^{-14} ± 6%	1.8×10^{-15} ± 5%	7.7×10^{-16} ± 12%	1.1×10^{-13} ± 3%
Mar	3.9×10^{-14} ± 4%	2.6×10^{-15} ± 5%	1.9×10^{-15} ± 8%	1.2×10^{-13} ± 2%
April	3.9×10^{-14} ± 5%	1.5×10^{-15} ± 7%	2.0×10^{-15} ± 11%	6.0×10^{-14} ± 2%
May	6.4×10^{-14} ± 3%	1.4×10^{-15} ± 16%	3.3×10^{-15} ± 5%	1.1×10^{-13} ± 2%
June	8.7×10^{-14} ± 5%	1.0×10^{-15} ± 16%	5.0×10^{-15} ± 4%	1.4×10^{-13} ± 2%
July	3.7×10^{-14} ± 4%	2.7×10^{-14} ± 8%	2.2×10^{-15} ± 6%	1.1×10^{-13} ± 2%
Aug	2.5×10^{-14} ± 4%	5.1×10^{-15} ± 4%	1.5×10^{-15} ± 7%	1.4×10^{-13} ± 2%
Sept	2.3×10^{-14} ± 5%	6.9×10^{-15} ± 4%	1.4×10^{-15} ± 13%	2.2×10^{-13} ± 2%
Oct	1.1×10^{-14} ± 4%	2.5×10^{-15} ± 6%	6.4×10^{-16} ± 15%	1.3×10^{-13} ± 2%
Nov	9.1×10^{-15} ± 4%	2.1×10^{-15} ± 6%	4.6×10^{-16} ± 16%	8.7×10^{-14} ± 2%
Dec	1.3×10^{-14} ± 3%	2.7×10^{-15} ± 5%	7.3×10^{-16} ± 15%	9.3×10^{-14} ± 2%
Annual avg	3.1×10^{-14}	2.3×10^{-15}	1.7×10^{-15}	1.2×10^{-13}
CG	2×10^{-10}	5×10^{-9}	9×10^{-10}	4×10^{-8}
%CG	1.6×10^{-2}	4.6×10^{-5}	1.9×10^{-4}	3×10^{-4}

Month	^{103}Ru	^{106}Ru	^{137}Cs	^{95}Zr	^{40}K
Jan	4.4×10^{-15} ± 6%	5.4×10^{-15} ± 6%	[illegible] ± 6%	1.1×10^{-14} ± 2%	2.1×10^{-16} ± 100%
Feb	4.5×10^{-15} ± 3%	8.5×10^{-15} ± 4%	1.1×10^{-15} ± 4%	1.2×10^{-14} ± 2%	2.1×10^{-16} ± 52%
Mar	7.0×10^{-15} ± 3%	2.0×10^{-14} ± 4%	1.2×10^{-15} ± 3%	2.4×10^{-14} ± 3%	1.8×10^{-16} ± [illegible]
April	4.6×10^{-15} ± 3%	2.1×10^{-14} ± 4%	5.4×10^{-15} ± 2%	2.0×10^{-14} ± 2%	1.0×10^{-16} ± 26%
May	4.6×10^{-15} ± 6%	5.4×10^{-14} ± 2%	5.4×10^{-15} ± 3%	2.4×10^{-14} ± 2%	3.2×10^{-16} ± 46%
June	3.9×10^{-15} ± 6%	4.6×10^{-14} ± 2%	8.4×10^{-15} ± 2%	2.6×10^{-14} ± 3%	3.7×10^{-16} ± 44%
July	3.1×10^{-15} ± 5%	2.0×10^{-14} ± 2%	1.5×10^{-15} ± 3%	1.0×10^{-14} ± 2%	2.0×10^{-16} ± 38%
Aug	4.2×10^{-15} ± 4%	1.3×10^{-14} ± 3%	[illegible] ± 3%	8.4×10^{-15} ± 4%	2.9×10^{-16} ± 38%
Sept	5.1×10^{-15} ± 3%	1.1×10^{-14} ± 7%	2.4×10^{-15} ± 5%	2.6×10^{-14} ± 3%	3.2×10^{-16} ± 42%
Oct	2.6×10^{-15} ± 5%	5.7×10^{-15} ± 4%	1.2×10^{-15} ± 5%	8.7×10^{-15} ± 3%	5.6×10^{-16} ± 34%
Nov	[illegible] ± 4%	4.4×10^{-15} ± 5%	9.1×10^{-16} ± 5%	9.1×10^{-15} ± 4%	2.6×10^{-16} ± 54%
Dec	4.1×10^{-15} ± 3%	6.2×10^{-15} ± 4%	3.2×10^{-15} ± 5%	1.1×10^{-14} ± 2%	5.2×10^{-17} ± 100%
Annual avg	4.2×10^{-15}	1.6×10^{-14}	2.9×10^{-15}	1.6×10^{-14}	2.7×10^{-16}
CG	3×10^{-9}	2×10^{-10}	5×10^{-10}	1×10^{-9}	4.0×10^{-9}
%CG	1.4×10^{-4}	8×10^{-3}	5.8×10^{-4}	1.6×10^{-3}	6.7×10^{-6}

Table 5. Plutonium, strontium, and uranium in air at LLL perimeter locations during 1974 (μCi/ml).

Month	*Location*[a]	Activity (μCi/ml)					Mass (μg/m^3)		
		^{239}Pu[b]	^{238}Pu	^{238}Pu/^{239}Pu	^{90}Sr	^{239}Pu/^{90}Sr	^{235}U	^{238}U	^{235}U/^{238}U
Jan	1	8.5×10^{-18} ± 11%	3.3×10^{-19} ± 60%	3.9×10^{-2}	1.1×10^{-15} ± 28%	7.7×10^{-3}	3.5×10^{-7} ± 3%	3×10^{-5} ± 4%	1.2×10^{-2}
	2	9.1×10^{-18} ± 13%	3.1×10^{-19} ± 49%	3.4×10^{-2}	7.0×10^{-16} ± 34%	1.3×10^{-2}	2.4×10^{-7} ± 3%	3.4×10^{-5} ± 3%	7.1×10^{-3}
	12	1.2×10^{-17} ± 11%	3.9×10^{-19} ± 35%	3.3×10^{-2}	1.0×10^{-15} ± 32%	1.2×10^{-2}	3.0×10^{-7} ± 3%	4.1×10^{-5} ± 3%	7.3×10^{-3}
	13	7.9×10^{-18} ± 12%	5.2×10^{-19} ± 34%	6.6×10^{-2}	8.5×10^{-16} ± 28%	9.3×10^{-3}	2.1×10^{-7} ± 3%	2.4×10^{-5} ± 3%	8.8×10^{-3}
	14	1.0×10^{-17} ± 9%	3.4×10^{-19} ± 34%	3.4×10^{-2}	9.8×10^{-16} ± 30%	1.0×10^{-2}	2.1×10^{-7} ± 2%	2.8×10^{-5} ± 3%	7.5×10^{-3}
	15	8.5×10^{-17} ± 10%	3.6×10^{-19} ± 31%	4.2×10^{-3}	8.9×10^{-16} ± 32%	9.6×10^{-2}	2.2×10^{-7} ± 3%	2.8×10^{-5} ± 5%	7.9×10^{-3}
Feb	1	1.3×10^{-17} ± 10%	4.6×10^{-19} ± 32%	3.6×10^{-2}	1.8×10^{-15} ± 18%	7.2×10^{-3}	2.6×10^{-7} ± 4%	3.0×10^{-5} ± 5%	8.7×10^{-3}
	2	1.7×10^{-17} ± 12%	5.0×10^{-19} ± 42%	2.9×10^{-2}	2.4×10^{-15} ± 15%	7.1×10^{-3}	3.1×10^{-7} ± 4%	4.1×10^{-5} ± 5%	7.6×10^{-3}
	12	1.6×10^{-17} ± 9%	8.5×10^{-19} ± 30%	5.3×10^{-2}	2.2×10^{-15} ± 18%	7.2×10^{-3}	3.3×10^{-7} ± 3%	4.9×10^{-5} ± 4%	6.7×10^{-3}
	13	1.1×10^{-17} ± 9%	5.2×10^{-19} ± 34%	4.7×10^{-2}	1.8×10^{-15} ± 13%	6.1×10^{-3}	2.0×10^{-7} ± 4%	2.9×10^{-5} ± 5%	6.9×10^{-3}
	14	2.4×10^{-17} ± 8%	1.1×10^{-18} ± 26%	4.6×10^{-2}	2.0×10^{-15} ± 14%	1.2×10^{-3}	2.4×10^{-7} ± 4%	3.5×10^{-5} ± 6%	6.9×10^{-3}
	15	1.4×10^{-17} ± 9%	4.0×10^{-19} ± 31%	2.9×10^{-2}	1.7×10^{-15} ± 14%	8.2×10^{-3}	2.3×10^{-7} ± 3%	3.4×10^{-5} ± 4%	6.8×10^{-3}
Mar	1	3.3×10^{-17} ± 9%	2.7×10^{-18} ± 49%	8.2×10^{-2}	2.5×10^{-15} ± 9%	1.3×10^{-2}	1.9×10^{-7} ± 3%	2.4×10^{-5} ± 4%	7.9×10^{-3}
	2	3.1×10^{-17} ± 9%	1.1×10^{-18} ± 35%	3.5×10^{-2}	2.6×10^{-15} ± 11%	1.1×10^{-2}	2.3×10^{-7} ± 3%	3.0×10^{-5} ± 4%	7.7×10^{-3}
	12	3.4×10^{-17} ± 12%	1.2×10^{-18} ± 45%	3.5×10^{-2}	2.8×10^{-15} ± 8%	1.2×10^{-2}	3.3×10^{-7} ± 4%	4.6×10^{-5} ± 4%	7.2×10^{-3}
	13	2.9×10^{-17} ± 10%	2.3×10^{-18} ± 71%	7.9×10^{-2}	2.4×10^{-15} ± 8%	1.2×10^{-2}	2.3×10^{-7} ± 4%	2.9×10^{-5} ± 5%	7.9×10^{-3}
	14	3.6×10^{-17} ± 9%	1.5×10^{-18} ± 32%	4.2×10^{-2}	2.5×10^{-15} ± 9%	1.4×10^{-2}	2.1×10^{-7} ± 5%	2.6×10^{-5} ± 7%	8.1×10^{-3}
	15	3.7×10^{-17} ± 11%	1.8×10^{-18} ± 34%	4.9×10^{-2}	2.3×10^{-15} ± 5%	1.6×10^{-2}	2.5×10^{-7} ± 4%	2.9×10^{-5} ± 5%	8.6×10^{-3}
Apr	1	4.5×10^{-17} ± 6%	1.0×10^{-18} ± 18%	2.2×10^{-2}	3.3×10^{-15} ± 10%	1.4×10^{-2}	1.8×10^{-7} ± 3%	2.5×10^{-5} ± 4%	7.2×10^{-3}
	2	5.1×10^{-17} ± 5%	1.3×10^{-18} ± 18%	2.5×10^{-2}	4.1×10^{-15} ± 9%	1.2×10^{-2}	2.1×10^{-7} ± 3%	2.7×10^{-5} ± 4%	8.4×10^{-3}
	12	5.4×10^{-17} ± 6%	1.9×10^{-18} ± 18%	3.5×10^{-2}	4.1×10^{-15} ± 9%	1.3×10^{-2}	3.3×10^{-7} ± 3%	4.7×10^{-5} ± 4%	7.0×10^{-3}
	13	5.0×10^{-17} ± 6%	9.9×10^{-19} ± 24%	2.0×10^{-2}	3.8×10^{-15} ± 9%	1.3×10^{-2}	2.2×10^{-7} ± 2%	2.9×10^{-5} ± 3%	7.6×10^{-3}
	14	5.3×10^{-17} ± 6%	1.1×10^{-18} ± 23%	2.1×10^{-2}	4.3×10^{-15} ± 9%	1.2×10^{-2}	2.1×10^{-7} ± 3%	3.0×10^{-5} ± 3%	7.0×10^{-3}
	15	4.8×10^{-17} ± 6%	1.1×10^{-18} ± 22%	2.3×10^{-2}	3.7×10^{-15} ± 10%	1.3×10^{-2}	2.1×10^{-7} ± 3%	2.9×10^{-5} ± 3%	7.2×10^{-3}
May	1	6.1×10^{-17} ± 10%	1.6×10^{-18} ± 42%	2.6×10^{-2}	7.6×10^{-15} ± 13%	8.0×10^{-3}	4.0×10^{-7} ± 5%	6.1×10^{-5} ± 7%	6.6×10^{-3}
	2	5.9×10^{-17} ± 10%	1.1×10^{-18} ± 37%	1.9×10^{-2}	7.5×10^{-15} ± 15%	7.9×10^{-3}	3.4×10^{-7} ± 2%	4.5×10^{-5} ± 3%	7.6×10^{-3}
	12	6.7×10^{-17} ± 11%	1.3×10^{-18} ± 45%	1.9×10^{-2}	9.4×10^{-15} ± 13%	7.1×10^{-3}	5.6×10^{-7} ± 2%	7.8×10^{-5} ± 3%	7.2×10^{-3}
	13	5.4×10^{-17} ± 10%	9.0×10^{-19} ± 45%	1.7×10^{-2}	7.6×10^{-15} ± 16%	7.1×10^{-3}	4.7×10^{-7} ± 2%	6.8×10^{-5} ± 3%	6.9×10^{-3}
	14	3.0×10^{-16} ± 8%	1.0×10^{-17} ± 20%	3.3×10^{-2}	7.6×10^{-15} ± 11%	3.9×10^{-2}	4.5×10^{-7} ± 2%	5.6×10^{-5} ± 3%	8.0×10^{-3}
	15	6.3×10^{-17} ± 11%	6.7×10^{-17} ± 45%	1.1×10^{-0}	7.6×10^{-15} ± 10%	8.3×10^{-3}	5.5×10^{-7} ± 2%	7.8×10^{-5} ± 2%	7.1×10^{-3}

Table 5 (continued).

Month	Location[a]	Activity (μCi/ml) ^{239}Pu[b]	^{238}Pu	$^{238}Pu/^{239}Pu$	^{90}Sr	$^{239}Pu/^{90}Sr$	Mass ($\mu g/m^3$) ^{235}U	^{238}U	$^{235}U/^{238}U$
June	1	7.4×10^{-17} ± 10%	2.1×10^{-18} ± 30%	2.8×10^{-2}	8.0×10^{-15} ± 11%	9.3×10^{-3}	3.4×10^{-7} ± 2%	4.6×10^{-5} ± 2%	7.4×10^{-3}
	2	7.3×10^{-17} ± 10%	4.1×10^{-18} ± 28%	5.6×10^{-2}	9.9×10^{-15} ± 11%	7.4×10^{-3}	5.7×10^{-7} ± 2%	6.1×10^{-5} ± 3%	9.3×10^{-3}
	12	7.9×10^{-17} ± 10%	2.9×10^{-17} ± 14%	3.7×10^{-1}	8.5×10^{-15} ± 11%	9.3×10^{-3}	5.8×10^{-7} ± 2%	8.3×10^{-5} ± 3%	7.0×10^{-3}
	13	8.5×10^{-17} ± 11%	2.2×10^{-18} ± 43%	2.6×10^{-2}	8.3×10^{-15} ± 19%	1.0×10^{-2}	4.6×10^{-7} ± 2%	6.3×10^{-5} ± 3%	7.3×10^{-3}
	14	1.2×10^{-16} ± 10%	5.2×10^{-18} ± 27%	4.3×10^{-2}	8.7×10^{-15} ± 16%	1.4×10^{-2}	4.9×10^{-7} ± 2%	6.7×10^{-5} ± 2%	7.3×10^{-3}
	15	7.7×10^{-17} ± 9%	1.9×10^{-18} ± 36%	2.5×10^{-2}	8.7×10^{-5} ± 18%	8.9×10^{-3}	5.5×10^{-7} ± 2%	7.5×10^{-5} ± 2%	7.3×10^{-3}
July	1	3.5×10^{-17} ± 14%	1.0×10^{-18} ± 56%	2.9×10^{-2}	1.7×10^{-15} ± 13%	2.1×10^{-2}	3.0×10^{-7} ± 2%	4.2×10^{-5} ± 2%	7.1×10^{-3}
	2	3.4×10^{-17} ± 13%	2.2×10^{-19} ± 40%	6.5×10^{-3}	1.6×10^{-15} ± 19%	2.1×10^{-2}	3.3×10^{-7} ± 2%	4.7×10^{-5} ± 3%	7.0×10^{-3}
	12	3.4×10^{-17} ± 14%	1.3×10^{-18} ± 42%	3.8×10^{-2}	1.6×10^{-15} ± 18%	2.1×10^{-2}	5.9×10^{-7} ± 2%	8.5×10^{-5} ± 2%	6.9×10^{-3}
	13	4.2×10^{-17} ± 14%	1.7×10^{-18} ± 38%	4.0×10^{-2}	1.8×10^{-15} ± 30%	2.3×10^{-2}	4.1×10^{-7} ± 2%	5.7×10^{-5} ± 3%	7.2×10^{-3}
	14	1.2×10^{-16} ± 7%	4.7×10^{-18} ± 20%	4.9×10^{-2}	2.1×10^{-15} ± 12%	5.7×10^{-2}	4.2×10^{-7} ± 2%	5.9×10^{-5} ± 2%	7.1×10^{-3}
	15	1.2×10^{-17} ± 35%	$<8.0 \times 10^{-20}$ ± 100%	$<6.7 \times 10^{-3}$	2.0×10^{-15} ± 14%	6.0×10^{-3}	5.0×10^{-7} ± 2%	7.1×10^{-5} ± 2%	7.0×10^{-3}
Aug	1	1.9×10^{-17} ± 21%	2.1×10^{-18} ± 59%	1.1×10^{-1}	1.2×10^{-15} ± 8%	1.6×10^{-2}	5.3×10^{-7} ± 2%	7.6×10^{-5} ± 2%	7.0×10^{-3}
	2	—[c]	—[c]		1.9×10^{-15} ± 9%		3.1×10^{-7} ± 2%	4.4×10^{-5} ± 3%	7.0×10^{-3}
	12	2.4×10^{-17} ± 85%	9.6×10^{-19} ± 25%	4.0×10^{-2}	1.4×10^{-15} ± 8%	1.7×10^{-2}	5.4×10^{-7} ± 2%	7.9×10^{-5} ± 3%	6.8×10^{-3}
	13	2.4×10^{-17} ± 8%	9.4×10^{-19} ± 26%	3.9×10^{-2}	1.3×10^{-15} ± 9%	1.8×10^{-2}	4.6×10^{-7} ± 2%	6.4×10^{-5} ± 3%	7.2×10^{-3}
	14	1.6×10^{-16} ± 6%	7.9×10^{-18} ± 16%	4.9×10^{-2}	1.6×10^{-15} ± 10%	1.0×10^{-1}	4.5×10^{-7} ± 2%	6.3×10^{-5} ± 3%	7.1×10^{-3}
	15	2.5×10^{-17} ± 8%	9.4×10^{-19} ± 28%	3.8×10^{-2}	1.4×10^{-15} ± 7%	1.8×10^{-2}	6.6×10^{-7} ± 2%	9.2×10^{-5} ± 2%	7.2×10^{-3}
Sept	1	4.8×10^{-17} ± 11%	7.6×10^{-19} ± 41%	1.6×10^{-2}	1.3×10^{-15} ± 12%	3.7×10^{-7}	4.9×10^{-7} ± 2%	6.8×10^{-5} ± 3%	7.2×10^{-3}
	2	1.5×10^{-17} ± 11%	$<8.0 \times 10^{-20}$ ± 100%	$<5.3 \times 10^{-3}$	8.3×10^{-16} ± 12%	1.8×10^{-2}	3.9×10^{-7} ± 2%	5.9×10^{-5} ± 2%	6.6×10^{-3}
	12	2.3×10^{-17} ± 9%	5.0×10^{-19} ± 39%	2.2×10^{-2}	1.7×10^{-15} ± 12%	1.4×10^{-2}	7.2×10^{-7} ± 2%	1.1×10^{-4} ± 3%	6.5×10^{-3}
	13	1.7×10^{-17} ± 9%	7.0×10^{-19} ± 32%	4.1×10^{-2}	1.4×10^{-15} ± 13%	1.2×10^{-2}	4.6×10^{-7} ± 2%	6.4×10^{-5} ± 2%	7.2×10^{-3}
	14	3.1×10^{-17} ± 9%	1.2×10^{-18} ± 28%	3.9×10^{-2}	1.4×10^{-15} ± 13%	2.2×10^{-2}	5.9×10^{-7} ± 2%	8.3×10^{-5} ± 2%	6.9×10^{-3}
	15	1.8×10^{-17} ± 10%	1.3×10^{-18} ± 28%	7.2×10^{-2}	1.3×10^{-15} ± 12%	1.4×10^{-2}	7.3×10^{-7} ± 12%	1.0×10^{-4} ± 12%	7.3×10^{-3}
Oct	1	2.3×10^{-17} ± 9%	6.4×10^{-19} ± 40	2.8×10^{-2}	1.9×10^{-15} ± 14%	1.2×10^{-2}	8.0×10^{-7} ± 2%	1.1×10^{-4} ± 2%	7.3×10^{-3}
	2	2.2×10^{-17} ± 11%	7.4×10^{-19} ± 45%	3.4×10^{-2}	1.1×10^{-15} ± 14%	2.0×10^{-2}	4.9×10^{-7} ± 2%	6.9×10^{-5} ± 2%	7.1×10^{-3}
	12	1.6×10^{-17} ± 10%	3.5×10^{-19} ± 46%	2.2×10^{-2}	1.9×10^{-15} ± 10%	8.4×10^{-3}	9.4×10^{-7} ± 2%	1.4×10^{-4} ± 2%	6.7×10^{-3}
	13	2.0×10^{-17} ± 12%	6.2×10^{-19} ± 36%	3.1×10^{-2}	1.5×10^{-15} ± 11%	1.3×10^{-2}	7.2×10^{-7} ± 2%	1.0×10^{-4} ± 2%	7.2×10^{-3}
	14	4.5×10^{-17} ± 8%	1.2×10^{-18} ± 31%	2.7×10^{-2}	1.3×10^{-15} ± 9%	3.5×10^{-2}	8.8×10^{-7} ± 2%	1.3×10^{-4} ± 2%	6.8×10^{-3}
	15	2.3×10^{-17} ± 11%	7.5×10^{-19} ± 39%	3.3×10^{-2}	2.0×10^{-15} ± 11%	1.2×10^{-2}	7.4×10^{-7} ± 2%	1.0×10^{-4} ± 3%	7.4×10^{-3}

Table 5 (continued).

Month	Location[a]	Activity (µCi/ml) ^{239}Pu[b]	^{238}Pu	$^{238}Pu/^{239}Pu$	^{90}Sr	$^{239}Pu/^{90}Sr$	Mass (µg/m³) ^{235}U	^{238}U	$^{235}U/^{238}U$
Nov	1	1.3×10^{-17} ± 14%	3.5×10^{-19} ± 67%	2.7×10^{-2}	1.0×10^{-15} ± 18%	1.3×10^{-2}	2.2×10^{-7} ± 2%	3.6×10^{-5} ± 3%	6.1×10^{-3}
	2	1.4×10^{-17} ± 16%	6.0×10^{-19} ± 40%	4.3×10^{-2}	9.7×10^{-16} ± 21%	1.4×10^{-2}	2.6×10^{-7} ± 2%	3.7×10^{-5} ± 3%	7.0×10^{-3}
	12	1.9×10^{-17} ± 12%	8.9×10^{-19} ± 41%	4.7×10^{-2}	1.3×10^{-15} ± 19%	1.5×10^{-2}	4.2×10^{-7} ± 2%	6.1×10^{-5} ± 3%	6.9×10^{-3}
	13[c]								
	14[c]								
	15	1.2×10^{-17} ± 13%	6.7×10^{-19} ± 43%	5.6×10^{-2}	1.2×10^{-15} ± 15%	1.0×10^{-2}	2.0×10^{-7} ± 2%	2.9×10^{-5} ± 3%	6.9×10^{-3}
Dec	1	1.3×10^{-17} ± 11%	7.5×10^{-19} ± 31%	5.8×10^{-2}	1.7×10^{-15} ± 14%	7.6×10^{-3}	2.6×10^{-7} ± 2%	7.4×10^{-5} ± 3%	3.5×10^{-3}
	2	1.2×10^{-17} ± 12%	3.8×10^{-19} ± 40%	3.2×10^{-2}	1.5×10^{-15} ± 16%	8.0×10^{-3}	2.1×10^{-7} ± 2%	5.6×10^{-5} ± 3%	3.8×10^{-3}
	12	1.8×10^{-17} ± 12%	9.9×10^{-19} ± 40%	5.5×10^{-2}	2.4×10^{-15} ± 13%	7.5×10^{-3}	5.0×10^{-7} ± 2%	1.5×10^{-4} ± 3%	3.4×10^{-3}
	13	1.4×10^{-17} ± 10%	4.0×10^{-19} ± 39%	2.9×10^{-2}	1.5×10^{-15} ± 15%	9.3×10^{-3}	2.4×10^{-7} ± 2%	6.2×10^{-5} ± 3%	3.8×10^{-3}
	14	2.3×10^{-17} ± 9%	$<1 \times 10^{-19}$ ± 100%	$<4.3 \times 10^{-3}$	1.8×10^{-15} ± 15%	1.3×10^{-2}	2.9×10^{-7} ± 3%	8.7×10^{-5} ± 4%	3.3×10^{-3}
	15	1.3×10^{-17} ± 13%	4.5×10^{-19} ± 52%	3.5×10^{-2}	1.6×10^{-15} ± 15%	8.1×10^{-3}	2.2×10^{-7} ± 2%	6.5×10^{-5} ± 3%	3.4×10^{-3}

Annual averages

Location	^{239}Pu (µCi/ml)	%CG[d]	^{238}Pu (µCi/ml)	%CG[e]	^{235}U (µg/m³)	%CG[f]	^{238}U (µg/m³)	%CG[g]
1	3.2×10^{-17}	5.3×10^{-2}	1.1×10^{-18}	1.6×10^{-3}	3.6×10^{-7}	1.9×10^{-5}	5.2×10^{-5}	3.5×10^{-4}
2	3.1×10^{-17}	5.2×10^{-2}	$<9.5 \times 10^{-19}$	1.4×10^{-3}	3.2×10^{-7}	1.7×10^{-5}	4.6×10^{-5}	3.1×10^{-4}
12	3.3×10^{-17}	5.5×10^{-2}	3.3×10^{-18}	4.7×10^{-3}	5.1×10^{-7}	2.7×10^{-5}	8.1×10^{-5}	5.4×10^{-4}
13	3.2×10^{-17}	5.3×10^{-2}	1.1×10^{-18}	1.6×10^{-3}	3.7×10^{-7}	2.0×10^{-5}	5.35×10^{-5}	3.6×10^{-4}
14	8.4×10^{-17}	1.4×10^{-1}	$<3.1 \times 10^{-18}$	4.4×10^{-3}	4.0×10^{-7}	2.1×10^{-5}	6.1×10^{-5}	4.0×10^{-4}
15	3.6×10^{-17}	6.0×10^{-2}	$<6.4 \times 10^{-18}$	9.1×10^{-3}	4.2×10^{-7}	2.2×10^{-5}	6.2×10^{-5}	4.1×10^{-4}

[a]See Fig. 1 for sampling locations.
[b]Activity listed as ^{239}Pu in this document includes activity due to the ^{240}Pu isotope.
[c]Sample lost.
[d]CG = 6×10^{-14} µCi/ml for ^{239}Pu in the soluble form.
[e]CG = 7×10^{-14} µCi/ml for ^{238}Pu in the soluble form.
[f]CG = 1.90 µg/m³ for ^{235}U in the insoluble form.
[g]CG = 15.0 µg/m³ for ^{238}U in the insoluble form.

Table 6. Plutonium, strontium, and uranium concentrations on air filters at Site 300 during 1974.

Month	Activity (μCi/ml) ^{239}Pu	Activity (μCi/ml) ^{238}Pu	$^{238}Pu/^{239}Pu$	Activity (μCi/ml) ^{90}Sr	$^{239}Pu/^{90}Sr$	Mass (μg/m^3) ^{235}U	Mass (μg/m^3) ^{238}U	$^{235}U/^{238}U$
Jan	$1.4 \times 10^{-17} \pm 6\%$	$7.4 \times 10^{-19} \pm 12\%$	5.3×10^{-2}	$6.3 \times 10^{-16} \pm 10\%$	2.2×10^{-2}	$1.9 \times 10^{-7} \pm 2\%$	$3.7 \times 10^{-5} \pm 3\%$	5.1×10^{-3}
Feb	$1.7 \times 10^{-17} \pm 5\%$	$7.6 \times 10^{-19} \pm 11\%$	4.5×10^{-2}	$9.6 \times 10^{-16} \pm 13\%$	1.8×10^{-2}	$5.0 \times 10^{-7} \pm 2\%$	$1.9 \times 10^{-4} \pm 4\%$	2.6×10^{-3}
Mar	$3.1 \times 10^{-17} \pm 6\%$	$1.0 \times 10^{-18} \pm 12\%$	3.2×10^{-2}	SAMPLE LOST		$3.5 \times 10^{-7} \pm 2\%$	$1.2 \times 10^{-4} \pm 4\%$	2.9×10^{-3}
Apr	$5.7 \times 10^{-17} \pm 6\%$	$1.7 \times 10^{-18} \pm 10\%$	3.0×10^{-2}	$4.2 \times 10^{-15} \pm 15\%$	1.4×10^{-2}	$2.9 \times 10^{-7} \pm 2\%$	$9.2 \times 10^{-5} \pm 4\%$	3.2×10^{-3}
May	$8.2 \times 10^{-17} \pm 8\%$	$2.0 \times 10^{-18} \pm 15\%$	2.4×10^{-2}	$9.9 \times 10^{-15} \pm 10\%$	8.3×10^{-3}	$3.6 \times 10^{-7} \pm 2\%$	$7.3 \times 10^{-5} \pm 4\%$	4.9×10^{-3}
June	$1.1 \times 10^{-16} \pm 7\%$	$2.4 \times 10^{-18} \pm 12\%$	2.2×10^{-2}	$8.8 \times 10^{-15} \pm 19\%$	1.3×10^{-2}	$3.4 \times 10^{-7} \pm 2\%$	$7.5 \times 10^{-5} \pm 4\%$	4.5×10^{-3}
July	$6.3 \times 10^{-17} \pm 16\%$	$1.2 \times 10^{-18} \pm 35\%$	1.9×10^{-2}	$2.6 \times 10^{-15} \pm 6\%$	2.4×10^{-2}	$4.3 \times 10^{-7} \pm 2\%$	$1.1 \times 10^{-4} \pm 3\%$	3.9×10^{-3}
Aug	$4.3 \times 10^{-17} \pm 9\%$	$5.7 \times 10^{-19} \pm 22\%$	1.3×10^{-2}	$2.0 \times 10^{-15} \pm 8\%$	2.2×10^{-2}	$5.6 \times 10^{-7} \pm 2\%$	$1.2 \times 10^{-4} \pm 3\%$	4.7×10^{-3}
Sept	$4.1 \times 10^{-17} \pm 7\%$	$1.2 \times 10^{-18} \pm 15\%$	2.9×10^{-2}	$2.2 \times 10^{-15} \pm 20\%$	1.9×10^{-2}	$1.2 \times 10^{-6} \pm 2\%$	$3.7 \times 10^{-4} \pm 3\%$	3.2×10^{-3}
Oct	$2.1 \times 10^{-17} \pm 6\%$	$1.1 \times 10^{-18} \pm 13\%$	5.2×10^{-2}	$9.5 \times 10^{-16} \pm 14\%$	2.2×10^{-2}	$6.7 \times 10^{-7} \pm 2\%$	$1.3 \times 10^{-4} \pm 3\%$	5.2×10^{-3}
Nov	$1.5 \times 10^{-17} \pm 6\%$	$3.7 \times 10^{-19} \pm 19\%$	2.5×10^{-2}	$1.3 \times 10^{-15} \pm 24\%$	1.2×10^{-2}	$1.6 \times 10^{-6} \pm 2\%$	$7.4 \times 10^{-4} \pm 3\%$	2.2×10^{-4}
Dec	$2.3 \times 10^{-17} \pm 6\%$	$6.9 \times 10^{-19} \pm 13\%$	3.0×10^{-2}	$1.9 \times 10^{-15} \pm 15\%$	1.2×10^{-2}	$5.2 \times 10^{-7} \pm 2\%$	$2.2 \times 10^{-4} \pm 3\%$	2.4×10^{-3}
Annual avg	4.3×10^{-17}	1.1×10^{-18}	2.7×10^{-2}	3.2×10^{-15}	1.3×10^{-2}	5.8×10^{-7}	1.9×10^{-4}	3.1×10^{-3}
CG	6×10^{-14} (soluble)	7×10^{-14} (soluble)		3×10^{-11} (soluble)		1.9 (insoluble)	1.5×10^{1} (insoluble)	
%CG	7.2×10^{-2}	1.6×10^{-3}		1.1×10^{-2}		3.1×10^{-5}	1.3×10^{-3}	

Table 7. Tritium (HTO) in air at LLL perimeters during 1974 (μCi/ml).

Location[a]	January - June: Number of samples	January - June: Maximum	January - June: Minimum	January - June: Average	July - December: Number of samples	July - December: Maximum	July - December: Minimum	July - December: Average	Annual avg	%CG[b]	Calculated annual adult whole-body dose (mrem)
1	23	$9.2 \times 10^{-11} \pm 7\%$	$7.6 \times 10^{-12} \pm 13\%$	3.8×10^{-11}	26	$7.8 \times 10^{-11} \pm 2\%$	$6.5 \times 10^{-12} \pm 25\%$	2.9×10^{-11}	3.3×10^{-11}	1.7×10^{-2}	4.6×10^{-2}
2	26	$9.3 \times 10^{-10} \pm 2\%$	$4.6 \times 10^{-12} \pm 22\%$	7.9×10^{-11}	26	$1.8 \times 10^{-10} \pm 2\%$	$1.7 \times 10^{-12} \pm 100\%$	3.3×10^{-11}	5.6×10^{-11}	2.8×10^{-2}	9.0×10^{-2}
12	24	$8.5 \times 10^{-10} \pm 1\%$	$2.0 \times 10^{-11} \pm 6\%$	1.2×10^{-10}	25	$3.1 \times 10^{-10} \pm 1\%$	$2.2 \times 10^{-12} \pm 58\%$	5.7×10^{-11}	8.6×10^{-11}	4.3×10^{-2}	1.4×10^{-1}
13	26	$1.0 \times 10^{-10} \pm 3\%$	$9.6 \times 10^{-12} \pm 13\%$	3.5×10^{-11}	26	$6.0 \times 10^{-11} \pm 7\%$	$1.6 \times 10^{-12} \pm 76\%$	1.9×10^{-11}	2.7×10^{-11}	1.3×10^{-2}	4.3×10^{-2}
14	24	$1.4 \times 10^{-10} \pm 5\%$	$2.8 \times 10^{-11} \pm 4\%$	6.2×10^{-11}	26	$1.4 \times 10^{-10} \pm 2\%$	$1.3 \times 10^{-11} \pm 7\%$	4.7×10^{-11}	5.4×10^{-11}	2.7×10^{-2}	8.6×10^{-2}
15	25	$9.6 \times 10^{-11} \pm 10\%$	$1.4 \times 10^{-11} \pm 10\%$	3.5×10^{-11}	26	$1.1 \times 10^{-10} \pm 2\%$	$5.3 \times 10^{-12} \pm 21\%$	2.1×10^{-11}	2.8×10^{-11}	1.4×10^{-2}	4.5×10^{-2}
Annual avg									4.7×10^{-11}	2.4×10^{-2}	7.5×10^{-2}

[a]See Fig. 1 for locations of perimeter sampling stations.

[b]Concentration Guide for HTO in air is 2×10^{-7} μCi/ml.

Table 8. Concentrations of various radionuclides in on-site LLL soil samples during 1974 (µCi/g — in dry weight).

Location[a]	Sampling depth (cm)	^{239}Pu	^{40}K	^{137}Cs	^{232}Th	^{235}U	^{238}U
429	0-5	9.2 × 10^{-8} ± 27%	9.55 × 10^{-6} ± 15%	2.61 × 10^{-7} ± 11%	5.45 × 10^{-7} ± 19%	3.28 × 10^{-8} ± 100%	7.43 × 10^{-7} ± 30%
430	0-5	8.7 × 10^{-8} ± 24%	9.50 × 10^{-6} ± 9.2%	1.49 × 10^{-7} ± 14%	5.41 × 10^{-7} ± 16%	2.24 × 10^{-8} ± 76%	5.63 × 10^{-7} ± 26%
431	0-5	1.1 × 10^{-7} ± 23%	9.50 × 10^{-6} ± 12%	1.19 × 10^{-7} ± 23%	5.23 × 10^{-7} ± 21%	2.27 × 10^{-8} ± 90%	8.24 × 10^{-7} ± 42%
432	0-5	2.1 × 10^{-7} ± 13%	8.96 × 10^{-6} ± 11%	2.14 × 10^{-7} ± 73%	4.95 × 10^{-7} ± 21%	1.55 × 10^{-8} ± 86%	7.97 × 10^{-7} ± 33%
433	0-5	2.9 × 10^{-8} ± 12%	9.82 × 10^{-6} ± 7%	1.93 × 10^{-7} ± 15%	4.50 × 10^{-7} ± 20%	1.61 × 10^{-8} ± 86%	7.03 × 10^{-7} ± 39%
434	0-5	6.1 × 10^{-8} ± 12%	1.00 × 10^{-5} ± 8.8%	2.13 × 10^{-7} ± 10%	4.95 × 10^{-7} ± 16%	2.43 × 10^{-8} ± 67%	6.76 × 10^{-7} ± 60%
435	0-5	3.0 × 10^{-8} ± 17%	1.09 × 10^{-5} ± 9.4%	3.45 × 10^{-7} ± 8.8%	4.42 × 10^{-7} ± 18%	2.08 × 10^{-8} ± 75%	5.63 × 10^{-7} ± 37%
436	0-5	1.2 × 10^{-8} ± 19%	1.27 × 10^{-5} ± 10%	1.51 × 10^{-7} ± 18%	6.85 × 10^{-7} ± 22%	4.00 × 10^{-8} ± 100%	7.66 × 10^{-7} ± 33%
437	0-5	5.4 × 10^{-9} ± 26%	1.36 × 10^{-5} ± 9.4%	1.95 × 10^{-7} ± 11%	7.12 × 10^{-7} ± 16%	2.82 × 10^{-8} ± 100%	5.72 × 10^{-7} ± 105%
438	0-5	1.2 × 10^{-8} ± 18%	1.19 × 10^{-5} ± 11%	1.23 × 10^{-7} ± 21%	6.71 × 10^{-7} ± 22%	2.50 × 10^{-6} ± 48%	5.54 × 10^{-7} ± 52%
439	0-5	5.1 × 10^{-9} ± 24%	1.43 × 10^{-5} ± 7.4%	1.57 × 10^{-7} ± 12%	6.76 × 10^{-7} ± 15%	3.90 × 10^{-8} ± 100%	6.49 × 10^{-7} ± 30%
440	0-5	1.3 × 10^{-8} ± 13%	1.36 × 10^{-5} ± 10%	2.39 × 10^{-7} ± 13%	7.07 × 10^{-7} ± 20%	1.76 × 10^{-8} ± 84%	4.14 × 10^{-7} ± 59%
441	0-5	1.1 × 10^{-7} ± 14%	9.50 × 10^{-6} ± 9.2%	3.68 × 10^{-7} ± 6.2%	5.59 × 10^{-7} ± 15%	2.71 × 10^{-8} ± 61%	7.21 × 10^{-7} ± 26%
442	0-5	1.2 × 10^{-7} ± 13%	9.14 × 10^{-6} ± 12%	1.84 × 10^{-7} ± 15%	5.59 × 10^{-7} ± 19%	4.12 × 10^{-8} ± 73%	6.67 × 10^{-7} ± 59%
443	0-5	3.3 × 10^{-8} ± 23%	1.21 × 10^{-5} ± 9.2%	5.41 × 10^{-8} ± 12%	5.95 × 10^{-7} ± 17%	2.41 × 10^{-8} ± 78%	7.43 × 10^{-7} ± 29%
444	0-5	1.1 × 10^{-7} ± 16%	1.01 × 10^{-5} ± 7.8%	1.28 × 10^{-7} ± 17%	5.90 × 10^{-7} ± 13%	3.66 × 10^{-8} ± 100%	5.90 × 10^{-7} ± 31%
445	0-5	1.6 × 10^{-8} ± 15%	9.55 × 10^{-6} ± 12%	1.40 × 10^{-7} ± 21%	6.13 × 10^{-7} ± 19%	2.72 × 10^{-8} ± 56%	6.49 × 10^{-7} ± 33%
446	0-5	1.9 × 10^{-8} ± 7%	9.59 × 10^{-6} ± 15%	7.80 × 10^{-7} ± 21%	5.36 × 10^{-7} ± 18%	9.23 × 10^{-9} ± 64%	5.95 × 10^{-7} ± 37%
447	0-5	1.7 × 10^{-8} ± 16%	1.21 × 10^{-5} ± 6.6%	5.41 × 10^{-8} ± 43%	4.73 × 10^{-7} ± 25%	1.51 × 10^{-8} ± 64%	4.95 × 10^{-7} ± 52%
448	0-5	1.0 × 10^{-8} ± 21%	1.21 × 10^{-5} ± 11%	7.16 × 10^{-8} ± 24%	7.66 × 10^{-7} ± 15%	3.41 × 10^{-8} ± 83%	8.47 × 10^{-7} ± 29%
449	0-5	2.2 × 10^{-8} ± 16%	1.25 × 10^{-5} ± 11%	8.87 × 10^{-8} ± 17%	1.07 × 10^{-6} ± 18%	3.14 × 10^{-8} ± 100%	6.04 × 10^{-7} ± 32%
450	0-5	3.3 × 10^{-9} ± 40%	1.33 × 10^{-5} ± 9.4%	1.00 × 10^{-7} ± 24%	9.91 × 10^{-7} ± 20%	4.50 × 10^{-8} ± 100%	7.97 × 10^{-7} ± 44%
451	0-5	1.3 × 10^{-8} ± 20%	1.26 × 10^{-5} ± 7.0%	1.11 × 10^{-7} ± 12%	1.00 × 10^{-6} ± 14%	2.32 × 10^{-8} ± 100%	7.34 × 10^{-7} ± 25%
452	0-5	9.2 × 10^{-9} ± 24%	1.18 × 10^{-5} ± 6.6%	1.05 × 10^{-7} ± 13%	8.02 × 10^{-7} ± 14%	2.66 × 10^{-8} ± 100%	6.53 × 10^{-7} ± 27%
453[c]							
454	0-5	3.7 × 10^{-8} ± 12%	9.73 × 10^{-6} ± 12%	6.71 × 10^{-7} ± 7.2%	5.41 × 10^{-7} ± 22%	3.81 × 10^{-8} ± 69%	6.89 × 10^{-7} ± 37%
455	0-5	4.4 × 10^{-8} ± 16%	9.73 × 10^{-6} ± 11%	4.27 × 10^{-7} ± 9.2%	5.72 × 10^{-7} ± 18%	3.98 × 10^{-8} ± 68%	5.77 × 10^{-7} ± 54%
456	0-5	1.7 × 10^{-7} ± 12%	9.59 × 10^{-6} ± 11%	5.05 × 10^{-7} ± 8.0%	5.41 × 10^{-7} ± 20%	1.19 × 10^{-8} ± 75%	5.14 × 10^{-7} ± 60%
457	0-5	1.3 × 10^{-7} ± 12%	1.02 × 10^{-5} ± 11%	2.06 × 10^{-7} ± 15%	5.36 × 10^{-7} ± 20%	2.16 × 10^{-8} ± 85%	5.36 × 10^{-7} ± 47%
458	0-5	2.0 × 10^{-8} ± 13%	9.91 × 10^{-6} ± 12%	5.59 × 10^{-8} ± 119%	6.04 × 10^{-7} ± 20%	3.71 × 10^{-8} ± 100%	7.25 × 10^{-7} ± 43%
459	0-5	1.2 × 10^{-8} ± 13%	1.20 × 10^{-5} ± 9.0%	4.12 × 10^{-8} ± 38%	5.90 × 10^{-7} ± 17%	2.31 × 10^{-8} ± 88%	7.66 × 10^{-7} ± 23%
460	0-5	1.9 × 10^{-8} ± 32%	1.16 × 10^{-5} ± 11%	1.54 × 10^{-7} ± 15%	5.54 × 10^{-7} ± 21%	3.45 × 10^{-8} ± 86%	7.03 × 10^{-7} ± 41%
461	0-5	1.1 × 10^{-8} ± 32%	1.20 × 10^{-5} ± 8%	3.05 × 10^{-8} ± 62%	5.90 × 10^{-7} ± 15%	2.13 × 10^{-8} ± 68%	8.15 × 10^{-7} ± 36%
462	0-5	1.2 × 10^{-9} ± 42%	9.68 × 10^{-6} ± 10%		5.81 × 10^{-7} ± 16%	2.85 × 10^{-8} ± 62%	6.85 × 10^{-7} ± 29%
463	0-5	5.6 × 10^{-9} ± 33%	1.34 × 10^{-5} ± 8%	1.80 × 10^{-7} ± 11%	5.27 × 10^{-7} ± 17%	2.01 × 10^{-8} ± 84%	8.92 × 10^{-7} ± 26%
464	0-5	6.1 × 10^{-9} ± 24%	1.35 × 10^{-5} ± 11%	1.64 × 10^{-7} ± 38%	5.41 × 10^{-7} ± 23%	2.75 × 10^{-8} ± 95%	6.94 × 10^{-8} ± 80%
465[c]							
466	0-5	4.0 × 10^{-8} ± 11%	1.14 × 10^{-5} ± 9.4%	4.68 × 10^{-7} ± 7.4%	4.86 × 10^{-7} ± 20%	2.27 × 10^{-8} ± 66%	7.16 × 10^{-7} ± 31%
467	0-5	3.9 × 10^{-7} ± 10%	9.73 × 10^{-6} ± 8.4%	4.03 × 10^{-7} ± 6.8%	6.26 × 10^{-7} ± 13%	3.13 × 10^{-8} ± 50%	8.74 × 10^{-7} ± 18%
468	0-5	1.2 × 10^{-6} ± 6%	9.64 × 10^{-6} ± 7.0%	8.57 × 10^{-7} ± 4.0%	5.95 × 10^{-7} ± 11%	1.37 × 10^{-8} ± 79%	6.87 × 10^{-7} ± 21%
469	0-5	1.4 × 10^{-8} ± 16%	1.14 × 10^{-5} ± 13%	3.75 × 10^{-7} ± 10%	5.41 × 10^{-7} ± 27%	3.89 × 10^{-8} ± 72%	5.36 × 10^{-7} ± 36%
470	0-5	5.1 × 10^{-8} ± 11%	1.18 × 10^{-5} ± 8.4%	1.86 × 10^{-7} ± 12%	4.77 × 10^{-7} ± 18%	3.87 × 10^{-8} ± 100%	6.76 × 10^{-7} ± 54%
471	0-5	2.3 × 10^{-8} ± 16%	1.03 × 10^{-5} ± 12%	1.21 × 10^{-7} ± 20%	4.77 × 10^{-7} ± 23%	1.87 × 10^{-8} ± 62%	5.77 × 10^{-7} ± 38%
472	0-5	6.4 × 10^{-9} ± 25%	1.19 × 10^{-5} ± 7.6%	2.65 × 10^{-8} ± 50%	5.68 × 10^{-7} ± 14%	2.69 × 10^{-8} ± 68%	6.80 × 10^{-7} ± 30%
473	0-5	1.5 × 10^{-8} ± 18%	1.25 × 10^{-5} ± 6.4%	5.27 × 10^{-8} ± 36%	5.31 × 10^{-7} ± 20%	1.72 × 10^{-8} ± 60%	6.04 × 10^{-7} ± 35%
474[c]							
475	0-5	9.6 × 10^{-7} ± 7%	1.03 × 10^{-5} ± 9.8%	3.74 × 10^{-7} ± 10%	4.95 × 10^{-7} ± 18%	3.94 × 10^{-8} ± 50%	7.34 × 10^{-7} ± 52%
476[c]							
477[c]							
478[c]							
479	0-5	3.8 × 10^{-8} ± 11%	1.20 × 10^{-5} ± 11%	5.36 × 10^{-8} ± 120%	5.22 × 10^{-7} ± 25%	2.29 × 10^{-8} ± 61%	6.67 × 10^{-7} ± 35%
480	0-5	5.7 × 10^{-8} ± 11%	9.14 × 10^{-6} ± 6.8%	2.87 × 10^{-7} ± 11%	3.50 × 10^{-7} ± 24%	7.75 × 10^{-8} ± 90%	5.95 × 10^{-7} ± 56%
481	0-5	1.2 × 10^{-8} ± 20%	1.12 × 10^{-5} ± 10%	2.86 × 10^{-7} ± 54%	5.27 × 10^{-7} ± 18%	2.24 × 10^{-8} ± 66%	4.42 × 10^{-7} ± 33%
482	0-5	4.1 × 10^{-9} ± 24%	1.12 × 10^{-5} ± 10%	1.13 × 10^{-7} ± 14%	5.09 × 10^{-7} ± 16%	2.13 × 10^{-8} ± 81%	8.33 × 10^{-7} ± 20%

[a]See Fig. 6 for locations of on-site LLL soil sampling.

[b]Activity ratio for natural uranium is 4.7 × 10^{-2}.

[c]No sample at this location.

Table 8A. Concentration of plutonium and americium in soil samples near the waste disposal area (µCi/g — in dry weight).

Location[a]	Sampling depth (cm)	^{239}Pu	^{238}Pu	$^{238}Pu/^{239}Pu$	^{241}Am
355	0-1	$9.1 \times 10^{-6} \pm 6\%$	$1.3 \times 10^{-6} \pm 8\%$	1.4×10^{-1}	$1.4 \times 10^{-6} \pm 14\%$
356	0-1	$5.1 \times 10^{-6} \pm 11\%$	$3.4 \times 10^{-7} \pm 14\%$	6.7×10^{-2}	$5.8 \times 10^{-7} \pm 7\%$
358	0-1	$1.8 \times 10^{-7} \pm 16\%$	$4.6 \times 10^{-8} \pm 26\%$	2.6×10^{-1}	$8.3 \times 10^{-7} \pm 60\%$
359	0-1	$1.7 \times 10^{-7} \pm 14\%$	$7.1 \times 10^{-8} \pm 18\%$	4.2×10^{-1}	$4.1 \times 10^{-8} \pm 100\%$

[a]See Fig. 6 for location of soil sampling sites.

Table 9. *Comparison* of plutonium concentrations in off-site soil samples during 1973 and 1974 (µCi/g — in dry weight).

Location[a]	Depth (cm)	1974: ^{239}Pu	1974: ^{238}Pu	$^{238}Pu/^{239}Pu$	Location[b]	Depth (cm)	1973: ^{239}Pu	1973: ^{238}Pu	$^{238}Pu/^{239}Pu$
517	0-1	$3.7 \times 10^{-8} \pm 21\%$	$4.3 \times 10^{-9} \pm 34\%$	1.2×10^{-1}	254	0-1	$6.7 \times 10^{-8} \pm 6\%$	$2.7 \times 10^{-10} \pm 8\%$	4.0×10^{-2}
520	0-1	$4.9 \times 10^{-8} \pm 6\%$	$5.6 \times 10^{-9} \pm 9\%$	1.2×10^{-1}	333	0-1	$5.3 \times 10^{-8} \pm 5\%$	SAMPLE LOST	-
522	0-1	$8.7 \times 10^{-8} \pm 6\%$	$8.2 \times 10^{-9} \pm 9\%$	9.4×10^{-2}	334	0-1	$5.4 \times 10^{-8} \pm 5\%$	SAMPLE LOST	-
524	0-1	$1.1 \times 10^{-8} \pm 5\%$	$8.4 \times 10^{-10} \pm 13\%$	7.6×10^{-2}	319	0-1	$1.8 \times 10^{-7} \pm 7\%$	$5.5 \times 10^{-9} \pm 9\%$	3.1×10^{-2}
526	0-1	$1.2 \times 10^{-8} \pm 5\%$	$5.5 \times 10^{-10} \pm 15\%$	4.6×10^{-2}	320	0-1	$1.4 \times 10^{-8} \pm 7\%$	$9.5 \times 10^{-10} \pm 17\%$	6.8×10^{-2}

[a] See Fig. 7 for sampling locations.

[b] These locations correspond to sampling locations during 1974.

Table 10. Plutonium, cesium, and uranium concentrations in *Site 300* soils during 1974.

Sampling location[a]	Depth (cm)	Activity µCi/g (dry wt): ^{239}Pu	Activity µCi/g (dry wt): ^{238}Pu	$^{238}Pu/^{239}Pu$	Activity µCi/g (dry wt): ^{137}Cs	Activity µg/g (dry wt): ^{235}U	Activity µg/g (dry wt): ^{238}U	$^{235}U/^{238}U$[b]
S-489	0-1	$5.1 \times 10^{-9} \pm 8\%$	$3.1 \times 10^{-10} \pm 22\%$	6.1×10^{-2}	$1.8 \times 10^{-7} \pm 44\%$	1.3[illegible] $\times 10^{-2} \pm 85\%$	$2.04 \pm 42\%$	5.54×10^{-3}
S-491	0-1	$3.3 \times 10^{-8} \pm 6\%$	$1.3 \times 10^{-9} \pm 13\%$	3.9×10^{-2}	$1.6 \times 10^{-6} \pm 3\%$	$9.11 \times 10^{-3} \pm 85\%$	$2.80 \pm 27\%$	3.25×10^{-3}
S-493	0-1	$1.6 \times 10^{-8} \pm 7\%$	$7.8 \times 10^{-10} \pm 16\%$	4.9×10^{-2}	$5.4 \times 10^{-7} \pm 8\%$	$7.24 \times 10^{-3} \pm 88\%$	$2.14 \pm 37\%$	3.38×10^{-3}
S-495	0-1	$1.0 \times 10^{-8} \pm 7\%$	$4.7 \times 10^{-10} \pm 18\%$	4.7×10^{-2}	$4.9 \times 10^{-7} \pm 5\%$	$1.56 \times 10^{-2} \pm 62\%$	$2.60 \pm 21\%$	6.00×10^{-3}
S-497	0-1	$2.4 \times 10^{-9} \pm 11\%$	$7.6 \times 10^{-11} \pm 40\%$	3.2×10^{-2}	$1.0 \times 10^{-7} \pm 31\%$	$1.89 \times 10^{-2} \pm 74\%$	$4.29 \pm 25\%$	4.41×10^{-3}
S-499	0-1	$1.2 \times 10^{-8} \pm 6\%$	$6.2 \times 10^{-10} \pm 15\%$	5.2×10^{-2}	$4.7 \times 10^{-7} \pm 8\%$	$1.04 \times 10^{-2} \pm 53\%$	$2.52 \pm 43\%$	4.13×10^{-3}
S-501	0-1	$9.7 \times 10^{-9} \pm 6\%$	$4.1 \times 10^{-10} \pm 18\%$	4.2×10^{-2}	$2.6 \times 10^{-7} \pm 12\%$	$3.92 \times 10^{-2} \pm 69\%$	$14.5 \pm 22\%$	2.70×10^{-3}
S-503	0-1	$2.1 \times 10^{-8} \pm 9\%$	$1.0 \times 10^{-9} \pm 24\%$	4.8×10^{-2}	$1.4 \times 10^{-7} \pm 13\%$	$2.61 \times 10^{-2} \pm 75\%$	$8.56 \pm 43\%$	3.05×10^{-3}
S-505	0-1	$2.2 \times 10^{-8} \pm 10\%$	$1.1 \times 10^{-9} \pm 26\%$	5.0×10^{-2}	$3.6 \times 10^{-7} \pm 8\%$	$1.29 \times 10^{-2} \pm 66\%$	$2.50 \pm 20\%$	5.16×10^{-3}
S-507	0-1	$3.3 \times 10^{-8} \pm 6\%$	$1.5 \times 10^{-9} \pm 13\%$	4.5×10^{-2}	$1.1 \times 10^{-6} \pm 5\%$	$2.13 \times 10^{-2} \pm 80\%$	$5.20 \pm 48\%$	4.10×10^{-3}
S-509	0-1	$2.5 \times 10^{-8} \pm 7\%$	$1.0 \times 10^{-9} \pm 17\%$	4.0×10^{-2}	$7.0 \times 10^{-7} \pm 5\%$	$1.70 \times 10^{-2} \pm 77\%$	$3.09 \pm 37\%$	5.50×10^{-3}

[a] See Fig. 8 for sample locations within Site 300.

[b] $^{235}U/^{238}U$ atomic ratio of natural uranium is 7.25×10^{-3}.

Table 11. Livermore sewage treatment plant gross alpha sampling results during 1974.

	Gross alpha activity (μCi/ml)							
		Digesters				Aeration tank		
Month	No. of samples	Maximum	Minimum	Average	No. of samples	Maximum	Minimum	Average
Jan.	10	$3.6 \times 10^{-7} \pm 29\%$	$1.1 \times 10^{-7} \pm 45\%$	2.1×10^{-7}	5	$4.9 \times 10^{-8} \pm 39\%$	$2.6 \times 10^{-8} \pm 52\%$	3.6×10^{-8}
Feb.	8	$2.0 \times 10^{-7} \pm 39\%$	$8.6 \times 10^{-8} \pm 54\%$	1.3×10^{-7}	4	$5.6 \times 10^{-8} \pm 38\%$	$1.1 \times 10^{-8} \pm 90\%$	3.6×10^{-8}
Mar.	8	$2.4 \times 10^{-7} \pm 34\%$	$4.9 \times 10^{-8} \pm 63\%$	1.3×10^{-7}	4	$5.6 \times 10^{-8} \pm 35\%$	$3.9 \times 10^{-8} \pm 42\%$	4.9×10^{-8}
Apr.	10	$2.0 \times 10^{-7} \pm 31\%$	$6.1 \times 10^{-8} \pm 61\%$	1.3×10^{-7}	5	$6.1 \times 10^{-8} \pm 34\%$	$2.9 \times 10^{-8} \pm 47\%$	4.3×10^{-8}
May	8	$2.4 \times 10^{-7} \pm 35\%$	$8.3 \times 10^{-8} \pm 43\%$	1.6×10^{-7}	4	$5.9 \times 10^{-8} \pm 32\%$	$2.9 \times 10^{-8} \pm 45\%$	3.7×10^{-8}
June	8	$2.8 \times 10^{-7} \pm 38\%$	$2.7 \times 10^{-8} \pm 49\%$	1.4×10^{-7}	4	$4.8 \times 10^{-8} \pm 40\%$	$3.1 \times 10^{-8} \pm 44\%$	3.7×10^{-8}
July	9	$4.7 \times 10^{-7} \pm 36\%$	$1.3 \times 10^{-7} \pm 42\%$	2.5×10^{-7}	5	$5.8 \times 10^{-8} \pm 32\%$	$2.4 \times 10^{-8} \pm 51\%$	4.2×10^{-8}
Aug.	8	$3.1 \times 10^{-7} \pm 31\%$	$1.4 \times 10^{-7} \pm 64\%$	2.1×10^{-7}	4	$4.9 \times 10^{-8} \pm 35\%$	$3.1 \times 10^{-8} \pm 44\%$	4.2×10^{-8}
Sept.	8	$1.7 \times 10^{-7} \pm 39\%$	$4.2 \times 10^{-9} \pm 62\%$	3.1×10^{-8}	4	$4.7 \times 10^{-8} \pm 42\%$	$2.3 \times 10^{-8} \pm 100\%$	3.3×10^{-8}
Oct.	10	$1.1 \times 10^{-8} \pm 51\%$	$5.1 \times 10^{-9} \pm 100\%$	8.7×10^{-9}	5	$4.5 \times 10^{-8} \pm 46\%$	$2.3 \times 10^{-8} \pm 62\%$	3.1×10^{-8}
Nov.	7	$1.8 \times 10^{-8} \pm 57\%$	$5.5 \times 10^{-9} \pm 57\%$	1.2×10^{-8}	4	$4.2 \times 10^{-8} \pm 49\%$	$5.2 \times 10^{-9} \pm 100\%$	3.0×10^{-8}
Dec.	9	$3.2 \times 10^{-9} \pm 44\%$	$1.1 \times 10^{-9} \pm 100\%$	2.3×10^{-9}	5	$2.6 \times 10^{-9} \pm 49\%$	$1.1 \times 10^{-9} \pm 100\%$	1.9×10^{-9}

Table 12. Livermore sewage treatment plant gross beta sampling results during 1974.

	Gross beta activity (μCi/ml)												
		Digesters				Aeration tank				Effluent			
Month	No. of samples	Maximum	Minimum	Average	No. of samples	Maximum	Minimum	Average	No. of samples	Maximum	Minimum	Average	%CG[a]
Jan.	10	$3.2 \times 10^{-7} \pm 17\%$	$1.8 \times 10^{-7} \pm 21\%$	2.4×10^{-7}	5	$4.1 \times 10^{-8} \pm 8\%$	$3.0 \times 10^{-8} \pm 10\%$	3.4×10^{-8}	12	$1.7 \times 10^{-8} \pm 45\%$	$9.2 \times 10^{-9} \pm 100\%$	1.3×10^{-8}	13
Feb.	8	$1.9 \times 10^{-7} \pm 17\%$	$1.3 \times 10^{-7} \pm 19\%$	1.6×10^{-7}	4	$3.2 \times 10^{-8} \pm 10\%$	$2.6 \times 10^{-8} \pm 11\%$	2.9×10^{-8}	21	$3.3 \times 10^{-8} \pm 25\%$	$8.5 \times 10^{-9} \pm 100\%$	1.4×10^{-8}	14
Mar.	8	$1.9 \times 10^{-7} \pm 17\%$	$6.9 \times 10^{-8} \pm 28\%$	1.4×10^{-7}	4	$3.8 \times 10^{-8} \pm 9\%$	$2.9 \times 10^{-8} \pm 10\%$	3.2×10^{-8}	28	$2.4 \times 10^{-8} \pm 33\%$	$8.4 \times 10^{-9} \pm 100\%$	1.3×10^{-8}	13
Apr.	10	$1.9 \times 10^{-7} \pm 18\%$	$9.9 \times 10^{-8} \pm 24\%$	1.4×10^{-7}	5	$3.2 \times 10^{-8} \pm 9\%$	$2.7 \times 10^{-8} \pm 11\%$	2.9×10^{-8}	30	$7.1 \times 10^{-8} \pm 16\%$	$7.5 \times 10^{-9} \pm 100\%$	1.8×10^{-8}	18
May	8	$1.5 \times 10^{-7} \pm 18\%$	$9.6 \times 10^{-8} \pm 21\%$	1.2×10^{-7}	4	$3.0 \times 10^{-8} \pm 10\%$	$2.1 \times 10^{-8} \pm 12\%$	2.5×10^{-8}	29	$1.6 \times 10^{-8} \pm 24\%$	$3.6 \times 10^{-9} \pm 34\%$	1.0×10^{-8}	10
June	8	$2.0 \times 10^{-7} \pm 16\%$	$4.5 \times 10^{-8} \pm 18\%$	1.2×10^{-7}	4	$3.7 \times 10^{-8} \pm 9\%$	$2.6 \times 10^{-8} \pm 11\%$	3.2×10^{-8}	29	$3.1 \times 10^{-8} \pm 28\%$	$8.3 \times 10^{-9} \pm 74\%$	1.4×10^{-8}	14
July	9	$3.5 \times 10^{-7} \pm 25\%$	$1.5 \times 10^{-7} \pm 21\%$	2.1×10^{-7}	5	$3.0 \times 10^{-8} \pm 10\%$	$2.3 \times 10^{-8} \pm 12\%$	2.7×10^{-8}	29	$1.6 \times 10^{-8} \pm 39\%$	$8.3 \times 10^{-9} \pm 75\%$	1.2×10^{-8}	12
Aug.	8	$4.3 \times 10^{-7} \pm 13\%$	$1.3 \times 10^{-7} \pm 27\%$	2.4×10^{-7}	4	$5.5 \times 10^{-8} \pm 6\%$	$2.5 \times 10^{-8} \pm 11\%$	4.1×10^{-8}	25	$2.4 \times 10^{-8} \pm 30\%$	$7.6 \times 10^{-9} \pm 100\%$	1.3×10^{-8}	13
Sept.	8	$2.2 \times 10^{-7} \pm 17\%$	$1.3 \times 10^{-8} \pm 18\%$	1.7×10^{-8}	4	$4.9 \times 10^{-8} \pm 10\%$	$3.1 \times 10^{-8} \pm 14\%$	3.9×10^{-8}	28	$2.1 \times 10^{-8} \pm 31\%$	$1.9 \times 10^{-9} \pm 100\%$	1.0×10^{-8}	10
Oct.	10	$2.1 \times 10^{-8} \pm 16\%$	$1.0 \times 10^{-8} \pm 21\%$	1.5×10^{-8}	5	$4.2 \times 10^{-8} \pm 12\%$	$3.0 \times 10^{-8} \pm 14\%$	3.6×10^{-8}	31	$1.7 \times 10^{-8} \pm 34\%$	$7.9 \times 10^{-10} \pm 38\%$	8.4×10^{-9}	8
Nov.	7	$5.0 \times 10^{-8} \pm 11\%$	$1.5 \times 10^{-8} \pm 19\%$	2.2×10^{-8}	4	$5.0 \times 10^{-8} \pm 11\%$	$5.7 \times 10^{-9} \pm 28\%$	3.1×10^{-8}	28	$3.3 \times 10^{-8} \pm 26\%$	$9.7 \times 10^{-10} \pm 100\%$	1.2×10^{-8}	12
Dec.	9	$2.4 \times 10^{-8} \pm 15\%$	$1.1 \times 10^{-8} \pm 22\%$	1.5×10^{-8}	5	$3.6 \times 10^{-8} \pm 13\%$	$1.7 \times 10^{-8} \pm 18\%$	2.[illegible] $\times 10^{-8}$	29	$2.2 \times 10^{-7} \pm 12\%$	$4.7 \times 10^{-9} \pm 43\%$	2.0×10^{-8}	20

[a] $CG = 1 \times 10^{-7}$ μCi/ml.

Table 13. Comparison of various radionuclides in LLL and Livermore treatment plant effluents during 1974 (μCi/ml).

	^{239}Pu		^{90}Sr		Tritium	
Month	LLL	Treatment plant	LLL	Treatment plant	LLL	Treatment plant
Jan.	3.7×10^{-10}	5.1×10^{-12}	2.0×10^{-9}	8.0×10^{-11}	4.7×10^{-6}	2.0×10^{-6}
Feb.	4.4×10^{-10}	7.8×10^{-12}	1.1×10^{-9}	3.7×10^{-10}	6.7×10^{-6}	1.3×10^{-6}
Mar.	1.8×10^{-10}	6.3×10^{-12}	5.9×10^{-10}	–[a]	9.0×10^{-6}	1.7×10^{-6}
Apr.	1.3×10^{-10}	4.1×10^{-12}	8.1×10^{-10}	2.3×10^{-10}	3.8×10^{-5}	6.8×10^{-6}
May	4.5×10^{-11}	7.2×10^{-12}	5.0×10^{-10}	–[a]	4.8×10^{-6}	2.8×10^{-6}
June	5.0×10^{-11}	1.3×10^{-12}	5.2×10^{-11}	2.2×10^{-10}	5.5×10^{-6}	3.6×10^{-6}
July	5.0×10^{-11}	1.2×10^{-12}	3.9×10^{-11}	1.1×10^{-10}	3.8×10^{-5}	5.2×10^{-6}
Aug.	5.0×10^{-10}	1.0×10^{-11}	8.9×10^{-11}	9.0×10^{-10}	6.6×10^{-5}	6.5×10^{-6}
Sept.	3.8×10^{-11}	3.2×10^{-11}	2.9×10^{-10}	6.5×10^{-10}	2.4×10^{-4}	2.0×10^{-5}
Oct.	1.4×10^{-10}	3.9×10^{-12}	6.7×10^{-10}	2.1×10^{-9}	7.8×10^{-5}	8.4×10^{-6}
Nov.	6.5×10^{-11}	5.2×10^{-12}	3.2×10^{-10}	6.1×10^{-10}	7.6×10^{-5}	7.0×10^{-6}
Dec.	2.7×10^{-10}	1.1×10^{-11}	4.6×10^{-10}	1.3×10^{-10}	4.4×10^{-5}	6.1×10^{-6}
Ann av	1.9×10^{-10}	7.9×10^{-12}	5.8×10^{-10}	4.5×10^{-10}	5.1×10^{-5}	6.0×10^{-6}
CG	3×10^{-5}	3×10^{-5}	3×10^{-7}	3×10^{-7}	3×10^{-3}	3×10^{-3}
%CG	6.3×10^{-4}	2.6×10^{-5}	1.9×10^{-1}	1.5×10^{-1}	1.7	2×10^{-1}

[a]Below the minimum detection limits.

Table 14. Gross beta activities in Livermore Valley water samples during 1974 (μCi/ml).

Location[a]	No. of samples	January - June Maximum	January - June Minimum	January - June Average	No. of samples	July - December Maximum	July - December Minimum	July - December Average	Annual average	%CG[b]
11	6	$3.5 \times 10^{-9} \pm 23\%$	$5.3 \times 10^{-10} \pm 37\%$	3.1×10^{-9}	6	$3.0 \times 10^{-9} \pm 33\%$	$1.7 \times 10^{-9} \pm 100\%$	2.5×10^{-9}	2.8×10^{-9}	9
13	6	$4.6 \times 10^{-9} \pm 34\%$	$1.7 \times 10^{-9} \pm 100\%$	3.1×10^{-9}	6	$2.6 \times 10^{-9} \pm 100\%$	$2.0 \times 10^{-9} \pm 61\%$	2.4×10^{-9}	2.7×10^{-9}	9
15	6	$3.9 \times 10^{-9} \pm 40\%$	$1.6 \times 10^{-9} \pm 29\%$	2.6×10^{-9}	6	$3.7 \times 10^{-9} \pm 32\%$	$1.7 \times 10^{-9} \pm 100\%$	2.6×10^{-9}	2.6×10^{-9}	9
16	6	$5.9 \times 10^{-9} \pm 29\%$	$2.3 \times 10^{-9} \pm 61\%$	3.5×10^{-9}	6	$8.9 \times 10^{-9} \pm 24\%$	$2.4 \times 10^{-9} \pm 100\%$	4.6×10^{-9}	4.1×10^{-9}	14
17	2[c]	$2.1 \times 10^{-9} \pm 66\%$	$1.9 \times 10^{-9} \pm 64\%$	2.0×10^{-9}	0[c]	-	-	-	-	
19	6	$2.3 \times 10^{-9} \pm 27\%$	$1.0 \times 10^{-9} \pm 29\%$	1.7×10^{-9}	6	$3.8 \times 10^{-9} \pm 31\%$	$1.7 \times 10^{-9} \pm 100\%$	2.5×10^{-9}	2.1×10^{-9}	7
20	3	$1.2 \times 10^{-8} \pm 18\%$	$6.0 \times 10^{-9} \pm 21\%$	8.3×10^{-9}	3	$1.4 \times 10^{-8} \pm 20\%$	$7.2 \times 10^{-9} \pm 24\%$	1.1×10^{-8}	9.5×10^{-9}	32
21	2[c]	$8.2 \times 10^{-9} \pm 23\%$	$4.5 \times 10^{-9} \pm 34\%$	6.4×10^{-9}	0[c]	-	-	-	-	
22	5[d]	$7.6 \times 10^{-9} \pm 19\%$	$3.4 \times 10^{-9} \pm 45\%$	6.2×10^{-9}	0[d]	-	-	-	6.2×10^{-9}	21
24	6	$4.1 \times 10^{-9} \pm 38\%$	$1.9 \times 10^{-9} \pm 27\%$	2.9×10^{-9}	6	$2.6 \times 10^{-8} \pm 15\%$	$4.7 \times 10^{-9} \pm 35\%$	9.3×10^{-9}	6.1×10^{-9}	20
26	6	$3.1 \times 10^{-9} \pm 48\%$	$1.8 \times 10^{-9} \pm 28\%$	2.4×10^{-9}	6	$2.8 \times 10^{-9} \pm 100\%$	$1.7 \times 10^{-9} \pm 100\%$	2.3×10^{-9}	2.3×10^{-9}	8
Annual avg									4.3×10^{-9}	14

[a] See Fig. 2 for sampling locations.

[b] Concentration Guide for gross beta activity in water is 3×10^{-8} μCi/ml.

[c] Sampling location discontinued.

[d] Sampling is from a rain pond which dried up in June 1974.

Table 15. Gross beta activities in Site 300 water samples during 1974 (μCi/ml).

Location[a]	No. of samples	January - June Maximum	January - June Minimum	January - June Average	No. of samples	July - December Maximum	July - December Minimum	July - December Average	Annual average	%CG[b]
1	6	$4.5 \times 10^{-9} \pm 34\%$	$1.4 \times 10^{-9} \pm 31\%$	3.2×10^{-9}	6	$4.7 \times 10^{-9} \pm 34\%$	$2.2 \times 10^{-9} \pm 60\%$	3.4×10^{-9}	3.3×10^{-9}	11
2	6	$7.6 \times 10^{-9} \pm 20\%$	$5.0 \times 10^{-9} \pm 31\%$	6.5×10^{-9}	6	$7.1 \times 10^{-9} \pm 25\%$	$3.1 \times 10^{-9} \pm 46\%$	5.0×10^{-9}	5.8×10^{-9}	19
3	6	$6.0 \times 10^{-9} \pm 21\%$	$4.6 \times 10^{-9} \pm 24\%$	5.2×10^{-9}	6	$7.8 \times 10^{-9} \pm 25\%$	$2.8 \times 10^{-9} \pm 34\%$	5.3×10^{-9}	5.2×10^{-9}	17
4	6	$7.3 \times 10^{-9} \pm 19\%$	$4.1 \times 10^{-9} \pm 36\%$	5.2×10^{-9}	6	$7.9 \times 10^{-9} \pm 24\%$	$2.8 \times 10^{-9} \pm 34\%$	5.4×10^{-9}	5.3×10^{-9}	18
5	6	$7.1 \times 10^{-9} \pm 25\%$	$3.4 \times 10^{-9} \pm 26\%$	4.9×10^{-9}	6	$6.3 \times 10^{-9} \pm 26\%$	$2.8 \times 10^{-9} \pm 34\%$	4.5×10^{-9}	4.7×10^{-9}	16
6	6	$5.3 \times 10^{-9} \pm 30\%$	$3.8 \times 10^{-9} \pm 40\%$	4.6×10^{-9}	6	$5.6 \times 10^{-9} \pm 30\%$	$3.6 \times 10^{-9} \pm 32\%$	4.2×10^{-9}	4.3×10^{-9}	14
7	6	$6.1 \times 10^{-9} \pm 21\%$	$2.4 \times 10^{-9} \pm 28\%$	4.6×10^{-9}	6	$5.1 \times 10^{-9} \pm 33\%$	$2.6 \times 10^{-9} \pm 100\%$	3.9×10^{-9}	4.2×10^{-9}	14
11	6	$7.6 \times 10^{-9} \pm 19\%$	$5.4 \times 10^{-9} \pm 30\%$	6.6×10^{-9}	6	$8.5 \times 10^{-9} \pm 23\%$	$3.2 \times 10^{-9} \pm 33\%$	5.8×10^{-9}	6.2×10^{-9}	21
14	6	$5.0 \times 10^{-9} \pm 22\%$	$1.7 \times 10^{-9} \pm 73\%$	3.1×10^{-9}	2	$3.2 \times 10^{-9} \pm 33\%$	$2.8 \times 10^{-9} \pm 34\%$	3.0×10^{-9}	3.1×10^{-9}	10
20	4	$2.6 \times 10^{-8} \pm 11\%$	$1.9 \times 10^{-9} \pm 69\%$	1.2×10^{-8}	3	$2.1 \times 10^{-8} \pm 13\%$	$5.2 \times 10^{-9} \pm 28\%$	1.1×10^{-8}	1.1×10^{-8}	37
21	3	$8.0 \times 10^{-9} \pm 19\%$	$6.1 \times 10^{-9} \pm 28\%$	7.2×10^{-9}	5	$1.1 \times 10^{-8} \pm 22\%$	$3.3 \times 10^{-9} \pm 100\%$	7.2×10^{-9}	7.2×10^{-9}	24
Annual avg									5.5×10^{-9}	18

[a]See Figs. 3 and 4 for sampling locations.

[b]Concentration Guide for gross beta activities in water is 3×10^{-8} μCi/ml.

Table 16. Tritium in water samples from Livermore Valley during 1974 (μCi/ml).

Location[a]	No. of samples	January - June			No. of samples	July - December			Annual average	%CG[b]	Calculated annual adult whole-body dose (mrem)
		Maximum	Minimum	Average		Maximum	Minimum	Average			
11	2	$1.5 \times 10^{-7} \pm 6.5\%$	$1.1 \times 10^{-7} \pm 8.2\%$	1.3×10^{-7}	2	$1.3 \times 10^{-7} \pm 8.5\%$	$1.1 \times 10^{-7} \pm 9.4\%$	1.2×10^{-7}	1.3×10^{-7}	4.2×10^{-3}	5.2×10^{-3}
15	2	$1.7 \times 10^{-7} \pm 6.1\%$	$1.5 \times 10^{-7} \pm 6.4\%$	1.6×10^{-7}	2	$1.4 \times 10^{-7} \pm 8.3\%$	$1.4 \times 10^{-7} \pm 7.0\%$	1.4×10^{-7}	1.5×10^{-7}	5.0×10^{-3}	6×10^{-3}
16	2	$3.4 \times 10^{-7} \pm 4.0\%$	$2.5 \times 10^{-7} \pm 4.6\%$	3.0×10^{-7}	2	$2.3 \times 10^{-7} \pm 5.5\%$	$2.0 \times 10^{-7} \pm 5.6\%$	2.1×10^{-7}	2.5×10^{-7}	8.5×10^{-3}	1.0×10^{-2}
17	1[c]	$1.2 \times 10^{-7} \pm 7.0\%$	$1.2 \times 10^{-7} \pm 7.0\%$	1.2×10^{-7}	0[c]	-	-	-	-	-	-
19	2	$1.5 \times 10^{-7} \pm 16.5\%$	$1.2 \times 10^{-7} \pm 7.6\%$	1.3×10^{-7}	2	$1.4 \times 10^{-7} \pm 8.4\%$	$1.1 \times 10^{-7} \pm 8.4\%$	1.3×10^{-7}	1.3×10^{-7}	4.3×10^{-3}	5.2×10^{-3}
20	2	$1.1 \times 10^{-6} \pm 16.1\%$	$6.1 \times 10^{-7} \pm 2.9\%$	8.7×10^{-7}	0[d]	-	-	-	-	-	-
21	1[c]	$1.5 \times 10^{-7} \pm 6.4\%$	$1.5 \times 10^{-7} \pm 6.4\%$	1.5×10^{-7}	0[c]	-	-	-	-	-	-
22	1[d]	$1.5 \times 10^{-7} \pm 5.8\%$	$1.5 \times 10^{-7} \pm 5.8\%$	1.5×10^{-7}	0[d]	-	-	-	-	-	-
24	2	$4.2 \times 10^{-7} \pm 3.3\%$	$2.1 \times 10^{-7} \pm 5.1\%$	3.1×10^{-7}	2	$2.9 \times 10^{-6} \pm 2.1\%$	$9.0 \times 10^{-7} \pm 3.9\%$	1.9×10^{-6}	1.1×10^{-6}	3.7×10^{-1}	4.4×10^{-2}
26	2	$2.1 \times 10^{-7} \pm 5.0\%$	$1.4 \times 10^{-7} \pm 6.7\%$	1.7×10^{-7}	2	$3.4 \times 10^{-7} \pm 4.1\%$	$2.5 \times 10^{-7} \pm 5.2\%$	2.9×10^{-7}	2.3×10^{-7}	7.7×10^{-3}	9.2×10^{-3}
Annual Average									3.3×10^{-7}	1.1×10^{-2}	1.3×10^{-2}

[a]See Fig. 2 for Livermore Valley water sampling locations.

[b]Concentration Guide for tritium in water is 3×10^{-3} μCi/ml.

[c]Sampling location was discontinued after March 1974.

[d]Sampling is from rain pond and rain gauge which did not have enough for proper sample.

Table 17. Tritium in water samples from Site 300 during 1974 (μCi/ml).

Location[a]	No. of samples	January-June			No. of samples	July-December			Annual average	%CG[b]	Calculated annual adult whole body dose (mrem)
		Maximum	Minimum	Average		Maximum	Minimum	Average			
1	3	$9.5 \times 10^{-8} \pm 9\%$	$2.2 \times 10^{-9} \pm 100\%$	5.3×10^{-8}	2	$1.1 \times 10^{-8} \pm 89\%$	$8.3 \times 10^{-9} \pm 100\%$	9.6×10^{-9}	3.1×10^{-8}	1.0×10^{-3}	1.2×10^{-3}
2	3	$5.4 \times 10^{-8} \pm 14\%$	$1.8 \times 10^{-8} \pm 100\%$	4.1×10^{-8}	2	$2.8 \times 10^{-8} \pm 34\%$	$1.5 \times 10^{-8} \pm 61\%$	2.1×10^{-8}	3.1×10^{-8}	1.0×10^{-3}	1.2×10^{-3}
3	3	$4.1 \times 10^{-8} \pm 19\%$	$7.2 \times 10^{-9} \pm 100\%$	2.8×10^{-8}	2	$2.0 \times 10^{-8} \pm 51\%$	$8.4 \times 10^{-9} \pm 100\%$	1.4×10^{-8}	2.1×10^{-8}	7.0×10^{-4}	8.4×10^{-4}
4	2	$2.9 \times 10^{-8} \pm 25\%$	$1.2 \times 10^{-8} \pm 71\%$	2.1×10^{-8}	2	$1.1 \times 10^{-8} \pm 81\%$	$9.6 \times 10^{-9} \pm 100\%$	1.0×10^{-8}	1.6×10^{-8}	5.3×10^{-4}	6.4×10^{-4}
5	2	$4.3 \times 10^{-8} \pm 18\%$	$3.5 \times 10^{-8} \pm 22\%$	3.9×10^{-8}	2	$5.1 \times 10^{-8} \pm$ [illegible]	$4.4 \times 10^{-8} \pm 19\%$	4.7×10^{-8}	4.3×10^{-8}	1.4×10^{-3}	1.7×10^{-3}
6	2	$5.8 \times 10^{-8} \pm 18\%$	$3.0 \times 10^{-8} \pm 27\%$	4.4×10^{-8}	2	$2.6 \times 10^{-8} \pm$ [illegible]	$1.0 \times 10^{-8} \pm 97\%$	1.8×10^{-8}	3.1×10^{-8}	1.0×10^{-3}	1.2×10^{-3}
7	2	$7.6 \times 10^{-8} \pm 10\%$	$3.8 \times 10^{-8} \pm 23\%$	5.7×10^{-8}	2	$3.4 \times 10^{-8} \pm 26\%$	$3.1 \times 10^{-8} \pm 33\%$	3.2×10^{-8}	4.5×10^{-8}	1.5×10^{-3}	1.8×10^{-3}
11	2	$2.3 \times 10^{-8} \pm 30\%$	$7.4 \times 10^{-9} \pm 100\%$	1.5×10^{-8}	2	$3.4 \times 10^{-8} \pm 28\%$	$1.4 \times 10^{-8} \pm 64\%$	2.4×10^{-8}	2.0×10^{-8}	6.7×10^{-4}	8.0×10^{-4}
14	2	$1.6 \times 10^{-7} \pm 6\%$	$1.3 \times 10^{-7} \pm 8\%$	1.4×10^{-7}	0[c]	—	—	—	—	—	—
20	2	$1.0 \times 10^{-7} \pm 38\%$	$7.5 \times 10^{-8} \pm 10\%$	8.9×10^{-8}	0[c]	—	—	—	—	—	—
21	1	$6.2 \times 10^{-8} \pm 13\%$	$6.2 \times 10^{-8} \pm 13\%$	6.2×10^{-8}	2	$9.9 \times 10^{-8} \pm 11\%$	$4.2 \times 10^{-8} \pm 26\%$	7.0×10^{-8}	6.6×10^{-8}	2.2×10^{-3}	2.6×10^{-3}
Annual avg									3.4×10^{-8}	1.1×10^{-3}	1.4×10^{-3}

[a]See Figs. 3 and 4 for Site 300 water sampling locations.

[b]Concentration Guide for tritium in water is 3×10^{-3} μCi/ml.

[c]Sampling is from rain pond and rain gauge which did not have enough for proper sample.

Table 18. Tritium in Livermore Valley vegetation during 1974 (µCi/g — dry wt).

Location[a]	No. of samples	January-June			No. of samples	July-December			Annual average	Calculated annual adult whole-body dose (mrem)
		Maximum	Minimum	Average		Maximum	Minimum	Average		
4	6	5.2×10^{-6} ± 7%	4.4×10^{-7} ± 100%	1.7×10^{-6}	6	3.9×10^{-6} ± 10%	5.5×10^{-7} ± 100%	1.3×10^{-6}	1.5×10^{-6}	2.3×10^{-2}
15	6	2.3×10^{-5} ± 3%	2.5×10^{-6} ± 12%	8.5×10^{-6}	6	1.1×10^{-5} ± 10%	1.4×10^{-6} ± 7%	4.7×10^{-6}	6.6×10^{-6}	9.9×10^{-2}
16	5	1.5×10^{-6} ± 36%	3.5×10^{-7} ± 76%	1.0×10^{-6}	6	1.2×10^{-6} ± 33%	1.3×10^{-7} ± 84%	6.3×10^{-7}	8.0×10^{-7}	1.2×10^{-2}
20	6	4.9×10^{-6} ± 32%	8.3×10^{-7} ± 45%	2.9×10^{-6}	6	2.5×10^{-6} ± 6%	5.7×10^{-7} ± 14%	1.4×10^{-6}	2.2×10^{-6}	3.3×10^{-2}
21	6	1.0×10^{-5} ± 4%	1.6×10^{-6} ± 19%	4.0×10^{-6}	6	3.8×10^{-6} ± 16%	7.9×10^{-7} ± 54%	1.9×10^{-6}	2.9×10^{-6}	4.4×10^{-2}
22	5	2.1×10^{-5} ± 4%	1.1×10^{-6} ± 21%	7.2×10^{-6}	6	5.1×10^{-6} ± 10%	8.1×10^{-7} ± 55%	2.0×10^{-6}	4.6×10^{-6}	6.9×10^{-2}
23	6	5.5×10^{-5} ± 2%	2.2×10^{-6} ± 9%	1.7×10^{-5}	6	2.0×10^{-5} ± 3%	3.2×10^{-8} ± 89%	3.9×10^{-6}	1.1×10^{-5}	1.7×10^{-1}
29	5	2.4×10^{-5} ± 23%	3.5×10^{-6} ± 9%	1.5×10^{-5}	6	2.1×10^{-5} ± 5%	3.6×10^{-6} ± 13%	1.2×10^{-5}	1.3×10^{-5}	2.0×10^{-1}
30	5	1.9×10^{-5} ± 4%	1.6×10^{-6} ± 78%	7.4×10^{-6}	6	1.4×10^{-5} ± 4%	1.2×10^{-6} ± 20%	6.7×10^{-6}	7.0×10^{-6}	1.1×10^{-1}
31	6	1.5×10^{-5} ± 5%	1.1×10^{-6} ± 30%	6.2×10^{-6}	6	2.6×10^{-5} ± 5%	5.3×10^{-7} ± 55%	5.4×10^{-6}	5.8×10^{-6}	8.7×10^{-2}
Annual avg									5.5×10^{-6}	8.3×10^{-2}

[a]See Fig. 2 for sampling locations.

Table 19. Tritium in Site 300 vegetation during 1974 (µCi/ml).

Location[a]	No. of samples	January-June			No. of samples	July-December			Annual average	Calculated annual adult whole-body dose (mrem)
		Maximum	Minimum	Average		Maximum	Minimum	Average		
1	6	1.0×10^{-6} ± 52%	3.0×10^{-7} ± 63%	5.7×10^{-7}	6	1.6×10^{-5} ± 63%	1.1×10^{-7} ± 100%	5.7×10^{-7}	5.7×10^{-7}	8.6×10^{-3}
2	6	1.0×10^{-6} ± 51%	3.7×10^{-7} ± 100%	6.8×10^{-7}	6	1.5×10^{-6} ± 7%	2.6×10^{-7} ± 68%	6.7×10^{-7}	6.7×10^{-7}	1.0×10^{-2}
3	6	1.0×10^{-6} ± 100%	1.3×10^{-7} ± 100%	6.4×10^{-7}	5	6.0×10^{-7} ± 83%	2.7×10^{-7} ± 100%	4.8×10^{-7}	5.7×10^{-7}	8.6×10^{-3}
5	6	1.5×10^{-6} ± 53%	5.3×10^{-7} ± 83%	9.4×10^{-7}	6	5.3×10^{-7} ± 65%	1.6×10^{-7} ± 49%	2.6×10^{-7}	6.0×10^{-7}	9.0×10^{-3}
6	6	1.8×10^{-5} ± 26%	5.4×10^{-6} ± 8%	1.0×10^{-5}	6	9.9×10^{-5} ± 1%	7.6×10^{-7} ± 36%	2.9×10^{-5}	1.9×10^{-5}	2.9×10^{-1}
11	6	1.0×10^{-6} ± 74%	4.6×10^{-7} ± 100%	7.7×10^{-7}	6	1.3×10^{-6} ± 7%	3.5×10^{-7} ± 100%	7.3×10^{-7}	7.5×10^{-7}	1.1×10^{-2}
12	5	1.2×10^{-6} ± 59%	2.8×10^{-7} ± 36%	7.6×10^{-7}	5	1.0×10^{-6} ± 8%	1.2×10^{-7} ± 100%	4.6×10^{-7}	6.1×10^{-7}	9.2×10^{-3}
13	6	3.0×10^{-5} ± 2%	6.3×10^{-7} ± 80%	9.8×10^{-6}	5	2.5×10^{-6} ± 15%	2.4×10^{-7} ± 42%	1.8×10^{-6}	5.8×10^{-6}	8.7×10^{-2}
Annual avg									3.6×10^{-6}	5.4×10^{-2}

[a]See Figs. 3 and 4 for sampling locations.

Table 20. Radionuclides observed in milk during 1974.

Radionuclide	No. of samples	Maximum	Minimum	Average	Calculated annual adult radiation dose (mrem)	Critical organ
^{137}Cs	12	$1.7 \times 10^{-9} \pm 46\%$	$5.7 \times 10^{-10} \pm 38\%$	9.7×10^{-10}	5.8×10^{-3}	Whole body
^{3}H	12	$6.3 \times 10^{-7} \pm 5\%$	$1.6 \times 10^{-7} \pm 100\%$	2.5×10^{-7}	7.6×10^{-4}	Whole body
^{40}K	12	$1.5 \times 10^{-6} \pm 4\%$	$1.1 \times 10^{-6} \pm 3\%$	1.3×10^{-6}	5.8	Whole body

Table 21. Environmental radiation background measurements at Lawrence Livermore Laboratory perimeters during 1974 (mrem).

Location[a]	January-March	April-June	July-September	October-December	Annual[b]
1	16	17	20	18	71
2	15	17	18	18	68
3	14	17	19	18	68
4	15	17	19	17	68
5	28	30	37	42	137[c]
6	14	17	18	19	68
7	12	15	16	14	57
8	14	16	19	17	66
9	15	15	18	17	65
10	17	17	20	20	74
11	15	18	20	20	73
12	16	19	20	19	74
Average	16	18	20	20	74

[a]See Fig. 1 for locations.

[b]None of these data have been corrected for natural background. TLD measurements in the off-site vicinity of LLL show an average of 68 mrem (Fig. 10).

[c]Neutron dose measurements (using an integrating rem meter) near Location 5 indicate an additional annual dose of approximately 370 mrem.

Table 22. Concentration of beryllium in LLL site perimeter air filters during 1974 ($\mu g/m^3$).[a]

Location[b]	January	February	March	April	May	June	July	August	September	October	November	December	Annual average
1	2.7×10^{-6}	2.2×10^{-5}	6.5×10^{-6}	1.0×10^{-5}	2.6×10^{-5}	2.6×10^{-5}	1.6×10^{-5}	2.6×10^{-5}	4.7×10^{-5}	4.8×10^{-5}	1.3×10^{-5}	5.2×10^{-6}	2.5×10^{-5}
2	7.2×10^{-6}	2.3×10^{-5}	2.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}	2.9×10^{-5}	2.4×10^{-5}	2.7×10^{-5}	2.3×10^{-5}	2.7×10^{-5}	1.9×10^{-5}	$<1.0 \times 10^{-7}$[c]	1.9×10^{-5}
12	1.3×10^{-5}	3.0×10^{-5}	2.8×10^{-5}	2.1×10^{-5}	4.5×10^{-5}	3.6×10^{-5}	3.4×10^{-5}	3.6×10^{-5}	6.1×10^{-5}	6.0×10^{-5}	2.8×10^{-5}	7.2×10^{-6}	3.3×10^{-5}
13	4.3×10^{-6}	1.3×10^{-5}	2.7×10^{-5}	1.4×10^{-5}	2.7×10^{-5}	2.6×10^{-5}	2.6×10^{-5}	3.1×10^{-5}	4.1×10^{-5}	4.2×10^{-5}	1.3×10^{-5}	$<1.0 \times 10^{-7}$	2.2×10^{-5}
14	4.5×10^{-6}	7.8×10^{-6}	1.2×10^{-5}	1.5×10^{-5}	1.6×10^{-5}	4.1×10^{-5}	3.1×10^{-5}	2.9×10^{-5}	5.2×10^{-5}	5.3×10^{-5}	1.6×10^{-5}	$<1.0 \times 10^{-7}$	2.3×10^{-5}
15	4.6×10^{-6}	1.1×10^{-5}	2.1×10^{-5}	1.1×10^{-5}	3.5×10^{-5}	4.7×10^{-5}	3.3×10^{-5}	3.4×10^{-5}	6.2×10^{-5}	4.7×10^{-5}	1.4×10^{-5}	5.9×10^{-6}	2.7×10^{-5}
Monthly avg	6.1×10^{-6}	1.8×10^{-5}	2.0×10^{-5}	1.4×10^{-5}	2.7×10^{-5}	3.4×10^{-5}	2.7×10^{-5}	3.1×10^{-5}	4.8×10^{-5}	4.6×10^{-5}	1.7×10^{-5}	$<3.1 \times 10^{-6}$	2.5×10^{-5}
% standard[a]	6.1×10^{-2}	1.8×10^{-1}	2.0×10^{-1}	1.4×10^{-1}	2.7×10^{-1}	3.4×10^{-1}	2.7×10^{-1}	3.1×10^{-1}	4.8×10^{-1}	4.6×10^{-1}	1.7×10^{-1}	$<3.1 \times 10^{-2}$	2.5×10^{-1}

[a]Emission standard is 1×10^{-2} $\mu g/m^3$ for a monthly average concentration as reported in the *Federal Register, April 6, 1973.*

[b]See Fig. 1 for sampling locations.

[c]Minimum detection value is 1×10^{-2} μg.

Table 23. Concentration of beryllium in Site 300 air filters during 1974 ($\mu g/m^3$).[a]

Location[a]	January	February	March	April	May	June	July	August	September	October	November	December	Annual average
1	3.4×10^{-6}	5.4×10^{-6}	7.8×10^{-6}	4.2×10^{-6}	1.1×10^{-5}	2.3×10^{-5}	1.6×10^{-5}	2.8×10^{-5}	4.3×10^{-5}	3.2×10^{-5}	1.2×10^{-5}	$<1.0 \times 10^{-7}$	1.6×10^{-5}
2	2.7×10^{-6}	1.4×10^{-4}	2.6×10^{-5}	1.1×10^{-5}	1.9×10^{-5}	5.2×10^{-5}	1.7×10^{-5}	2.4×10^{-5}	3.1×10^{-5}	3.2×10^{-5}	1.8×10^{-5}	9.1×10^{-6}	3.2×10^{-5}
3	3.5×10^{-6}	1.5×10^{-5}	1.9×10^{-5}	6.3×10^{-6}	2.1×10^{-5}	3.2×10^{-5}	1.4×10^{-5}	4.0×10^{-5}	5.4×10^{-5}	4.2×10^{-5}	2.8×10^{-4}	2.1×10^{-5}	4.6×10^{-5}
4	7.2×10^{-7}	2.3×10^{-5}	2.7×10^{-5}	1.0×10^{-5}	3.4×10^{-5}	2.7×10^{-5}	1.2×10^{-5}	3.0×10^{-5}	4.3×10^{-5}	3.5×10^{-5}	1.6×10^{-5}	$<1.0 \times 10^{-7}$	2.2×10^{-5}
5	6.5×10^{-6}	1.4×10^{-5}	1.9×10^{-5}	1.1×10^{-5}	1.7×10^{-5}	3.0×10^{-5}	1.2×10^{-5}	3.1×10^{-5}	5.3×10^{-5}	4.2×10^{-5}	2.0×10^{-5}	$<1.0 \times 10^{-7}$	2.1×10^{-5}
7	4.3×10^{-6}	1.8×10^{-5}	3.1×10^{-6}	9.4×10^{-6}	2.1×10^{-5}	5.4×10^{-5}	1.1×10^{-5}	3.1×10^{-5}	3.9×10^{-5}	2.8×10^{-5}	2.0×10^{-5}	$<1.0 \times 10^{-7}$	2.2×10^{-5}
8	4.1×10^{-6}	1.3×10^{-5}	1.9×10^{-5}	1.3×10^{-5}	2.5×10^{-5}	3.0×10^{-5}	1.5×10^{-5}	2.5×10^{-5}	3.9×10^{-5}	4.2×10^{-5}	1.8×10^{-5}	$<1.0 \times 10^{-7}$	2.0×10^{-5}
9	6.5×10^{-7}	1.6×10^{-5}	$<1.0 \times 10^{-7}$[c]	3.4×10^{-6}	1.7×10^{-5}	1.9×10^{-5}	2.1×10^{-5}	2.4×10^{-5}	4.2×10^{-5}	4.0×10^{-5}	1.7×10^{-5}	$<1.0 \times 10^{-7}$	1.7×10^{-5}
10	4.2×10^{-6}	1.0×10^{-5}	2.2×10^{-5}	4.7×10^{-5}	2.4×10^{-5}	2.3×10^{-5}	3.5×10^{-5}	4.1×10^{-5}	3.2×10^{-5}	1.3×10^{-4}	3.4×10^{-5}	9.0×10^{-6}	3.4×10^{-5}
11	6.7×10^{-6}	1.8×10^{-5}	2.2×10^{-5}	$<1.0 \times 10^{-7}$	1.7×10^{-5}	2.4×10^{-5}	9.7×10^{-6}	2.6×10^{-5}	3.1×10^{-5}	3.9×10^{-5}	1.7×10^{-5}	9.3×10^{-6}	1.8×10^{-5}
Monthly avg	3.7×10^{-6}	2.7×10^{-5}	$<1.7 \times 10^{-5}$	$<1.2 \times 10^{-5}$	2.1×10^{-5}	3.1×10^{-5}	1.6×10^{-5}	3.0×10^{-5}	4.1×10^{-5}	4.6×10^{-5}	4.5×10^{-5}	$<4.8 \times 10^{-6}$	2.1×10^{-5}
% standard[a]	3.7×10^{-2}	2.7×10^{-1}	$<1.7 \times 10^{-1}$	$<1.2 \times 10^{-1}$	2.1×10^{-1}	3.1×10^{-1}	1.6×10^{-1}	3.0×10^{-1}	4.1×10^{-1}	4.6×10^{-1}	4.5×10^{-1}	$<4.8 \times 10^{-2}$	2.1×10^{-1}

[a]Emission standard is 1×10^{-2} $\mu g/m^3$ for a monthly average concentration as reported in the Federal Register, April 6, 1973.

[b]See Fig. 3 for sampling locations.

[c]Minimum detection value is 1×10^{-2} μg.

Table 24. Monthly average concentrations of various metallic elements in LLL sewage effluent during 1974 (mg/l).

Month	Cd	Cr	Cu	Fe	Pb	Ag	Zn
January	0.02 ± 0.001	0.26 ± 0.03	6.34 ± 0.50	4.29 ± 0.50	0.49 ± 0.02	0.36 ± 0.02	1.55 ± 0.20
February	0.01 ± 0.001	0.28 ± 0.03	5.40 ± 0.50	5.03 ± 0.50	0.63 ± 0.02	0.23 ± 0.01	1.04 ± 0.10
March	0.01 ± 0.001	0.25 ± 0.03	4.90 ± 0.50	3.49 ± 0.30	0.23 ± 0.01	0.16 ± 0.01	1.16 ± 0.10
April	0.04 ± 0.002	0.28 ± 0.03	2.47 ± 0.20	5.07 ± 0.50	0.71 ± 0.02	0.18 ± 0.01	1.15 ± 0.10
May	0.02 ± 0.001	0.14 ± 0.02	1.74 ± 0.20	2.21 ± 0.20	0.41 ± 0.02	0.14 ± 0.01	0.52 ± 0.05
June	0.01 ± 0.001	0.18 ± 0.02	1.13 ± 0.10	1.75 ± 0.20	0.32 ± 0.01	0.20 ± 0.01	0.56 ± 0.05
July	0.01 ± 0.001	0.20 ± 0.02	0.95 ± 0.10	1.90 ± 0.20	0.40 ± 0.02	0.20 ± 0.01	0.47 ± 0.05
August	0.01 ± 0.001	0.16 ± 0.02	0.96 ± 0.10	1.96 ± 0.20	0.21 ± 0.01	0.19 ± 0.01	0.37 ± 0.05
September	0.03 ± 0.001	0.1[illegible] ± 0.02	0.97 ± 0.10	1.92 ± 0.20	0.11 ± 0.01	0.17 ± 0.01	0.38 ± 0.05
October	0.01 ± 0.001	0.16 ± 0.02	0.90 ± 0.10	1.68 ± 0.20	0.10 ± 0.01	0.24 ± 0.01	0.31 ± 0.05
November	0.02 ± 0.001	0.12 ± 0.01	1.28 ± 0.10	2.90 ± 0.30	0.10 ± 0.01	0.21 ± 0.01	0.59 ± 0.05
December	0.01 ± 0.001	0.11 ± 0.01	2.00 ± 0.20	2.80 ± 0.30	0.10 ± 0.01	0.12 ± 0.01	0.76 ± 0.10
Annual avg	0.02 ± 0.01	0.19 ± 0.06	2.42 ± 1.97	2.92 ± 1.27	0.32 ± 0.21	0.20 ± 0.06	0.74 ± 0.40

Table 25. Physical and chemical analysis of LLL sewage effluent.

	Sewage, 24-hr composite, mg/l
Biological Oxygen Demand (BOD, 5 day 20 C)	72
Chemical Oxygen Demand (COD)	180
Ammonia nitrogen[a]	15
Total Kjeldahl nitrogen[a]	27
Nitrate nitrogen[a]	1.0
Oil and grease (Freon extraction)	16
Sulfate (SO_4)	46
Arsenic	<0.001
Boron	0.35
Cyanide (CN)	0.11
Mercury	0.0018
Selenium	0.016
Settleable matter, ml/l/hr	2.0
Total solids	189
Total dissolved solids	156
Total suspended solids	7
Alkalinity phenolphthalein, mg/l $CaCO_3$	51
Total	113

[a]Sample preserved by mercuric chloride.

Table 26. Radiation dose to the public from LLL radioactive effluents.

Nuclide	Facility	Curie release	Season	Site boundary, "fence post" (mrem)	Nearest downwind resident (mrem)	Within 80-km radius of LLL (man-rem)
^{41}Ar	281	680	wet	6.1	0.76	1.3
			dry			0.7
			annual			2.0
$^{3}H_2$	331	1300	wet	0.12	0.0099	0.08
			dry			0.04
			annual			0.12
$^{3}H_2$	212	560	wet	0.75	0.0091	0.05
			dry			0.03
			annual			0.08
$^{13}N_2$-$^{15}O_2$	194	1300	wet	0.0056	0.0014	
			dry			
			annual			

Table 27. Percent of Concentration Guide of the radionuclide detected in discharges to Livermore City Sewer System.[a]

Radionuclide	RC[b]	%RG
^{134}Cs	9×10^{-6}	6.9×10^{-1}
^{137}Cs	2×10^{-5}	3.1×10^{-1}
^{65}Zn	1×10^{-4}	6.2×10^{-2}
^{56}Mn	1×10^{-4}	6.2×10^{-2}
^{60}Co	3×10^{-3}	2.1×10^{-3}
^{95}Zr	8×10^{-4}	7.8×10^{-3}
^{95}Nb	1×10^{-4}	6.2×10^{-2}
^{125}Sb	1×10^{-4}	6.2×10^{-2}
^{110}Ag	3×10^{-5}	2.1×10^{-1}

[a]Assuming each of the radionuclides was the sole source of the 6.2×10^{-8} μCi/ml of gross beta activity detected on the annual average.

[b]AEC Manual Chapter 0524, Annex A, Table II.

References

1. Camp, D. C., Gatrousis, C., and Maynard, L. A., "Low Background Ge(Li) Detector Systems for Radioenvironmental Studies," Nucl. Instr. Methods 117 (1974).
2. Silver, W. J., Lindeken, C. L., Meadows, J. W., Hutchin, W. H., and McIntyre, D. R., Environmental Levels of Radioactivity in the Vicinity of the Lawrence Livermore Laboratory 1973 Annual Report, Lawrence Livermore Laboratory, UCRL-51547 (1974).
3. Cambray, R. S., Eakins, J. D., Fisher, E. M. R., and Peirson, D. H., Radioactive Fallout in Air and Rain, Environmental and Medical Sciences Division, AERE Harwell, Oxfordshire, AERE-R-7832 (1974).
4. Hardy, E. P., Fallout Program Quarterly Summary Report, USAEC Health and Safety Laboratory, HASL-276, October 1973.
5. Gudiksen, P. H., Lindeken, C. L., Meadows, J. W., and Hamby, K. O., Environmental Levels of Radioactivity in the Vicinity of the LLL 1972 Annual Report, Lawrence Livermore Laboratory, UCRL-51333 (1973).
6. Coles, D. G., Meadows, J. W., and Lindeken, C. L., A Convenient Method for the Direct Measurement of Uranium in Soil Samples Using High Resolution Ge(Li) Gamma Ray Spectroscopy, Lawrence Livermore Laboratory, UCRL-75619 Rev. 1 (1974).
7. Anspaugh, L. R., Koranda, J. J., Robison, W. L., and Martin, J. R., The Dose to Man Via Food-Chain Transfer Resulting from Exposure to Tritiated Water Vapor, Lawrence Livermore Laboratory, UCRL-73195 Rev. 1 (1972).
8. Agricultural Statistics, 1969, United States Department of Agriculture, U. S. Government Printing Office, Washington, D. C. (1969).
9. Lindeken, C. L., Gudiksen, P. H., Meadows, J. W., Hamby, K. O., and Anspaugh, L. R., Environmental Levels of Radioactivity in Livermore Valley Soils, Lawrence Livermore Laboratory, UCRL-74424 (1973).
10. Lowder, W. M. and Beck, H. L., "Cosmic Ray Ionization in the Lower Atmosphere," J. Geo. Phys. Rev. 71 4611 (1966).
11. Cate, J. L., Jr. and Hoeger, T. O., "A Radioisotope Monitoring System for Sewage Effluent," Am. Industrial Hygiene Assn. J. 33 10 693 (1972).
12. Gifford, F. A., Jr. and Hilsmeier, W. F., Graphs for Estimating Atmospheric Dispersion, ORO-545, Oak Ridge, Tennessee.

Appendix A
Discharge Limits to the Sanitary Sewer System of the City of Livermore

The Code of the City of Livermore (1959) states the discharge requirements to its sanitary sewer system in Section 18.63. These limits are as follows:

Sec. 18.63.

No person shall discharge, or cause to be discharged, except for salt waste discharge from water softener units of any kind or description installed and in operation on or before January 31, 1966, which are regenerated by the owner thereof at the place of use of such units, any of the following described water or wastes to any public sewer unless the customer obtains a permit from the city in accordance with section 18.65:

(a) Any liquor or vapor having a temperature higher than one hundred fifty degrees Fahrenheit.

(b) Any waters or wastes which contain more than two hundred ppm of fat, oil or grease that is petroleum ether soluble.

(c) Any gasoline, benzene, naphtha, fuel oil or other inflammable or explosive liquid, solid or gas.

(d) Any garbage, except properly ground with a mechanical garbage grinder. Specifically excluded from the sewers are waste products resulting from the handling, storage and sale of fruits and vegetables from other than retail produce establishments, or other foods not intended primarily for immediate consumption.

(e) Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, coal tar, asphalt, cement, plastics, woods, paunch manure or any other solid viscous substance capable of causing obstruction to the flow in sewers or other interferences with the proper economical operation of the sewage works.

(f) Any wastes or water with a pH lower than six and eight-tenths or higher than eight.

(g) Any waters or wastes containing total dissolved solids increment greater than three hundred and twenty-five ppm, nor chloride increment greater than seventy-five ppm, increase during a single cycle use of the water supply.

(h) Any water or wastes having a B.O.D. greater than three hundred ppm (the average B.O.D. for residential users).

(i) Any waters or wastes containing more than three hundred ppm of suspended solids (the average suspended solids for residential users).

(j) Any waters intended to be used or used to dilute waste discharge to avoid violation of the above limitation. (Ord. No. 586. par 1.)

Sec. 18.66

No person shall discharge or cause to be discharged any radioactive wastes into any public sewers, except where:

A. The waste is discharged in strict conformity with current atomic energy commission recommendations for safe disposal of radioactive wastes.

B. The discharging of radioactive waste will not cause injury to personnel or damage to the sewage works. Any person discharging a radioactive waste to a public sewer in accordance with the provisions of the preceding paragraph shall submit to the council such report as the council may deem necessary.

In the event of any accidental spill of any radioactive material into the public sewer, the person responsible shall (a) immediately notify the plant superintendent, and (b) render such technical or other assistance to the department of public works within his power to prevent the sewage works from becoming contaminated with radioactivity.
(Ord. No. 586, par 1.)

Appendix B
Environmental Activity Concentration Guide Levels

The Standards for Radiation Protection (AEC Manual Chapter 0524, issued 11/8/68) state that if there is a mixture in air and water of radionuclides whose identity and concentrations are unknown, the average activity should not exceed the following values:

1.	Air (controlled area)	6×10^{-12} μCi/ml
2.	Air (uncontrolled area)	2×10^{-14} μCi/ml
3.	Water (controlled area)	4×10^{-7} μCi/ml
4.	Water (uncontrolled area)	3×10^{-8} μCi/ml

If it is known that alpha emitters and ^{227}Ac are not present, the following guide values may be used to determine the permissible average activity:

5.	Air (controlled area)	3×10^{-11} μCi/ml
6.	Air (uncontrolled area)	1×10^{-12} μCi/ml

If it is known that ^{129}I, ^{226}Ra, and ^{228}Ra are not present, the following values may be used:

7.	Water (controlled area)	3×10^{-6} μCi/ml
8.	Water (uncontrolled area)	1×10^{-7} μCi/ml

The air and water samples are subjected to gross alpha and gross beta measurements. The average annual alpha activities may not exceed those listed under points 1 through 4 above. Since the alpha emitters have been accounted for in the gross alpha measurements, and the assumption is made that ^{129}I, ^{227}Ac, ^{226}Ra, and ^{228}Ra are not present in the samples, and annual average gross beta activities of the samples may not exceed the activities listed under points 5 through 8 above. The assumption that ^{129}I, ^{227}Ac, ^{226}Ra, and ^{228}Ra are not present in air and water samples is reasonable in view of the minute quantities of these radionuclides available at the Laboratory. AEC Manual Chapter 0524 also states that the average tritium activities in off-site water samples may not exceed 3×10^{-3} μCi/ml.

Since analysis for ^{129}I, ^{226}Ra, and ^{228}Ra activities is made on samples collected from the Laboratory's sewage effluent at the point of discharge into the Livermore city sanitary sewer system, the gross alpha and beta activities in the samples collected from the effluent discharged from the Livermore sewage treatment plant should not exceed the 1×10^{-7} μCi/ml listed under point 8 above.

The annual external whole-body radiation dose to workers in controlled areas may not exceed 5 rem; while that to an individual in an uncontrolled area may not exceed 500 mrem. An average annual dose of 170 mrem may not be exceeded for a group of individuals in an uncontrolled area.