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DESERT RESEARCH INSTITUTE
UNIVERSITY OF NEVADA SYSTEM

OFF-SITE RADIATION EXPOSURE REVIEW PROJECT
PHASE II SOILS PROGRAM

by
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ABSTRACT

To help estimate population doses of radiation from fallout originating at the Nevada Test Site, soil samples were collected throughout the western United States. Each sample was prepared by drying and ball-milling, then analyzed by gamma-spectrometry to determine the amount of ^{137}Cs it contained. Most samples were also analyzed by chemical separation and alpha-spectrometry to determine $^{239+240}Pu$ and by isotope mass spectroscopy to determine the ratios of ^{240}Pu to ^{239}Pu and ^{241}Pu to ^{239}Pu. The total inventories of cesium and plutonium at 171 sites were computed from the results.

This report describes the sample collection, processing, and analysis, presents the analytical results, and assesses the quality of the data. Use of the results reported here to estimate the fraction of the total inventories originating from the NTS and to estimate population exposures will be described in a separate report (Anspaugh, L.R., and H.L. Beck, 1989. The County Data Base: Estimates of exposure rates and times of fallout arrival in the Off-Site Radiation Exposure Review Project Phase II area. NVO-320, Nevada Operations Office, U.S. Department of Energy, Las Vegas).

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SECTION 1
INTRODUCTION

THE ORERP

Between January 1951 and July 1962, the United States conducted 100 above-ground tests of nuclear explosives at the Nevada Test Site (NTS). Radioactive fallout from about three-quarters of these tests reached populated areas off the NTS, and in recent years concern about the possible effects of this fallout on human populations has increased. Studies such as those by Lyon *et al.* (1979) and Archer (1987) have reported a relationship between leukemia rates and fallout, and lawsuits have been filed against the government contending that the health of people living downwind from the NTS has been affected by exposure to NTS fallout.

One response of the U.S. Department of Energy (DOE) to the increase in public concern and litigation was to begin the Off-Site Radiation Exposure Review Project (ORERP) in 1979. The ORERP has two primary objectives:

1. To collect and make accessible to the public all available unclassified information about fallout from nuclear testing at the NTS. This is the purpose of the Coordination and Information Center (CIC) in Las Vegas, which currently contains more than 140,000 documents about off-site fallout and related subjects.

2. To estimate the radiation dose that off-site populations are likely to have received as a result of NTS testing. The ultimate goal of this aspect of the ORERP is an Individual Dose Assessment computer model to estimate the probable dose to any person based on place of residence, lifestyle, dietary habits, and other personal data.

The soils program described in this report is one of several components of the dose-assessment task of the ORERP, and the next sub-section briefly describes its role in the overall project. For a more complete description of all the components of the ORERP and how they fit together, see Friesen (1985).

ROLE OF THE SOILS PROGRAM

A key element of the dose-assessment model is the estimation of how much NTS fallout was deposited at any particular location. Fallout deposition at locations near the NTS

can be estimated fairly well from the large amount of monitoring data collected after every atmospheric nuclear test. (For example, one ORERP database of survey-meter readings contains results from over 80,000 fallout measurements.) These data, combined with information about the fallout patterns of individual tests, enable the estimation of fallout deposition throughout eastern Nevada and southwestern Utah, the so-called Phase I region.

In 1981, the Dose Assessment Advisory Group (DAAG), an independent panel of scientists, physicians, and representatives of state governments that reviewed and advised the ORERP from 1980 to 1987, recommended that the project attempt to estimate exposures in areas outside the limited region covered by fallout monitors. This recommendation was motivated by a study done in Utah by DOE's Environmental Measurements Laboratory (EML) in 1979, which showed that the population exposure to external gamma radiation from NTS fallout was higher in northern Utah than in most counties closer to the NTS (Krey and Beck, 1981; Beck and Krey, 1983). Thus began Phase II of the ORERP, an investigation of radiation exposures in the rest of Nevada and Utah and parts of the surrounding states.

A major part of Phase II was the collection of soil samples at more than 100 communities in 1982. The data from the soil samples are combined with other data, including measurements of fallout collected between 1951 and 1958 at a network of gummed film stations (Beck, 1984), to estimate population exposures in the Phase II region. Because these data are much less extensive than the monitoring data for the Phase I region, the Phase II dose estimates are being made for entire counties or parts of counties rather than for individual communities. The estimates will be contained in the County Database (Anspaugh and Beck, 1989), one of several databases used by the Individual Dose Assessment model.

In 1983 the soil sampling was extended to other cities in the western U.S. that were also part of the gummed-film network. These data help define the geographical distribution of NTS fallout even though they are not complete enough for detailed exposure estimates throughout a large region. The 1983 effort is sometimes called Phase III of the ORERP, but for this report the distinction between Phase II and Phase III sites is immaterial: The same procedures were used to collect, process, and analyze the soil samples in both phases.

The analysis of most of the soil samples was completed by the end of 1985, and conclusion of the project was anticipated in 1986. However, unanticipated levels of plutonium at sites in Albuquerque, New Mexico, led the project managers to order collection of additional samples there and in other communities in New Mexico and Arizona in 1986 and 1987.

Figure 1 shows the locations of the communities in the western U.S. where samples were collected. Samples were also collected at three midwestern cities not shown in Figure 1. The EML study included soil samples from 55 communities in Utah, and most of these communities were not included in the ORERP sampling program.

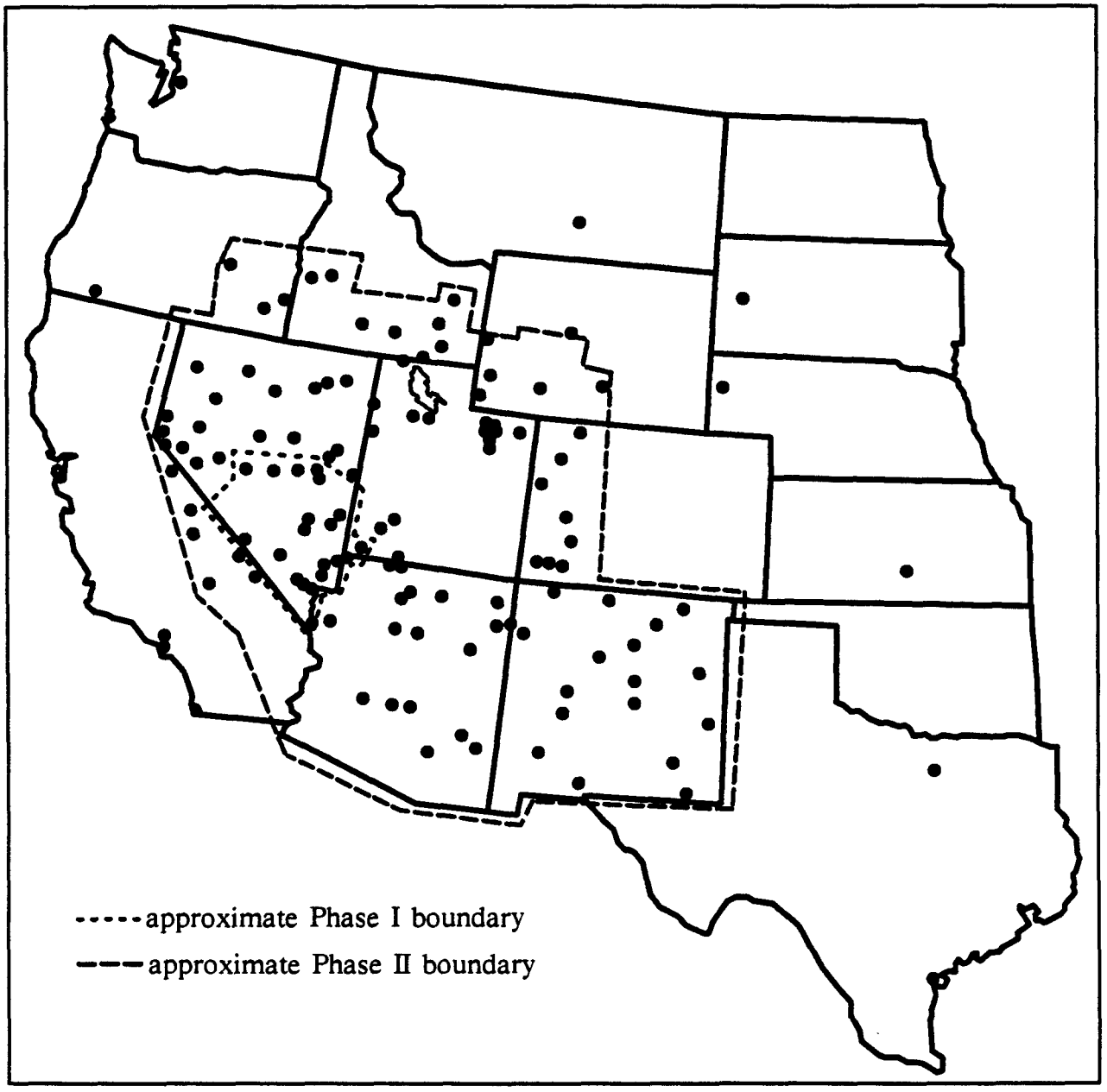

Figure 1. Locations in the western U.S. where soil samples were collected. Samples were also collected in Des Moines, Iowa; St. Louis, Missouri; and Memphis, Tennessee.

PROGRAM OVERVIEW

The ORERP soil sampling was designed as an expansion of EML's Utah study, which relied primarily on using measurements of radioactivity in the soil to estimate the amount of fallout deposited at a given site. For the method to give accurate results, it is essential that the soil have remained undisturbed since extensive nuclear testing began in the early 1950s. EML found that undisturbed soil was generally most likely to be found beneath old, well-established lawns.

The first step in the ORERP program was therefore to decide which communities were to be included and visit each one to try to find sites with 30-year-old lawns. Potential sites were first identified by visual inspection and interviews with local residents to verify the site's age and undisturbed status. Then a preliminary measurement of the ^{137}Cs (henceforth denoted as "Cs") in the soil was made by *in situ* spectrometry to help verify that the site was indeed undisturbed. After the initial site selection, soil samples were collected at one or more sites in each community and sent to the laboratory, where they were processed and analyzed for Cs and isotopes of plutonium. The procedures by which this was done are summarized in Section 2 and given in detail in Appendix A, the project directive which specified the step-by-step operational procedures for the program. Appendix B lists each potential site that was identified and summarizes the extent to which it was analyzed.

Section 3 describes how the amounts of Cs and $^{239+240}Pu$ (henceforth denoted as "Pu") deposited at a site were calculated from the analytical results and presents the results of those calculations. The analytical results for each sample that was at least partially analyzed are given in Appendix C.

Quality assurance (QA) was an important element of every step of the program. Much of the QA associated with the sample collection and processing is described in Section 2. Section 4 discusses the more quantitative QA involved with the spectrometric and radiochemical analysis of the samples.

The Cs and Pu inventories reported in Section 3 are only the first part of the analysis of the data. Scientists at EML have developed equations for calculating the fraction of the total inventory that can be attributed to fallout from the NTS. (This is possible because the ratios of plutonium isotopes in fallout from the relatively low-yield fission tests at the NTS are different from the ratios in "global" fallout, which includes fallout from U.S. thermonuclear tests in the Pacific and tests conducted by other countries.) In addition, the amounts of other radionuclides in the fallout can often be estimated from the Cs

and plutonium measurements. Discussion of how the soil data are used to estimate NTS fallout and how the fallout estimates are used to estimate radiation exposure is beyond the scope of this report. Those calculations will be carried out by other ORERP scientists and presented in a report on the County Database (Anspaugh and Beck, 1989).

ACKNOWLEDGMENTS

The ORERP is a joint effort of the DOE and several contracting organizations. The organizations that took part in the soil sampling program, their roles in the program, and the names of the senior scientists and managers are given below. No attempt will be made to list the many other people who played a part in the program, but without their dedication the project could not have been completed.

DOE/Nevada Operations Office (DOE/NV)

Overall management of the entire ORERP.

Bruce Church, ORERP Project Director
Marshall Page, Deputy Project Manager
Charles Campbell, Deputy Project Manager
Richard Nutley, Assistant Project Manager
David L. Wheeler, Assistant Project Manager

DOE/Environmental Measurements Laboratory (EML)

General supervision and review to ensure that the work was consistent with previous EML studies; design of the QA program.

Harold Beck
Philip Krey

Lawrence Livermore National Laboratory (LLNL)

Technical direction of the program; field spectrometry measurements.

Lynn R. Anspaugh, ORERP Scientific Director
John Koranda

Reynolds Electrical and Engineering Co., Inc. (REECo)

Collection, processing, and analysis of the soil samples.

Howard Hawthorne
Frank Markwell
Bernardo Maza
Tom Mehas
Billy Smith
Steve Rohrer
Roger Thompson

Desert Research Institute (DRI)

Initial selection of sampling sites; administration of the QA program; design and management of the project database.

Forest L. Miller

The authors are especially grateful to Harold Beck of EML for his careful review of earlier drafts of this report.

SECTION 2
METHODS

SITE SELECTION

Many aspects of the soils program were managed by a supervisory committee of the project managers and scientists and EML advisors. The first task of this committee was to choose the communities to be included. Each community was then visited to try to find at least three sites that met the criteria developed by EML to ensure that the soil radioactivity at a site was representative of the fallout deposition in a community. An essential requirement was that the soil not have been disturbed since 1950. No plowing or grading of the land, no addition or removal of soil, and no animal burrowing should have occurred. The site must also have had some type of ground cover so that water and wind erosion were minimal, and it must not have been subjected to the addition of blowsand by wind or silt by irrigation or flooding. Activities such as normal watering, mowing, weeding, and fertilizing were allowable.

Preferred sites were flat, open, grassy areas at least 40 feet across that were not close to buildings, roads, or natural obstructions that could affect fallout deposition, were not higher or lower than the surrounding land (to minimize runoff or pooling of fallout), and had minimal rock outcroppings or debris. Lawns in parks, school yards, churches, and cemeteries were often ideal sites because they were large and their age was usually relatively easy to verify. Lawns at private homes were also suitable, though they tended to be smaller and closer to buildings and trees, and often nobody could be found who knew whether a lawn had been undisturbed since 1950. Pastures with dense vegetation were also possible sites, but they were less desirable than well-maintained lawns.

Most sites were chosen by two-person teams from DRI; the sites sampled in 1986 and 1987 were chosen by a representative from DOE's Albuquerque Operations Office. The approach to the site-selection task varied with the people involved and with the size of the community. In the small towns, sites were typically found simply by driving around town, spotting a good-looking lawn, and stopping to talk to the homeowner. Whether or not the first lawn turned out to be suitable, the owner often knew everybody else in town and was

able to direct the team to other sites. In larger towns, a visit to the city hall or county courthouse usually led quickly to the identification of old parks, golf courses, school yards, and cemeteries. Most visits to large cities in 1983 were preceded by letters or phone calls to the city or county parks department. The parks people were generally very cooperative and often assigned someone to assist the site selection team when it arrived.

The search for sites naturally focused on lawns, and it was usually possible to find at least three suitable lawns in a town of any size. In parts of the Southwest, however, lawns, especially 30-year-old ones, are few and far between. In these areas, the teams had to use less desirable sites in pastures, meadows, and deserts. The EML criteria were somewhat loosely applied at this early stage, as it seemed more efficient to have the selection teams identify a number of possible sites and let the sampling teams choose the best ones than to have the sampling teams spend their time finding alternative sites.

Regardless of how they found their sites, the teams visited each one to confirm that it met the physical criteria. Many teams took photographs of their sites as well. They also talked to the landowners or local officials to verify that each site had been undisturbed for at least 30 years and obtain permission for sampling.

Each team kept careful notes and filled out a form describing each site and how to find it and giving the name of the person to call to arrange for sampling. When the team returned to Las Vegas, the forms were typed and copies sent to DOE, LLNL, and REECo. At this time, each site was given an identifier consisting of a two-letter code derived from the team members' initials and a two-digit sequence number (*e.g.*, AF01). This identifier was used to label the site for all subsequent processing and analysis.

Appendix B lists all 565 sites that were identified. It includes every site found by DRI, several alternative sites chosen by the LLNL and REECo teams, and five sites from the EML study that were included as part of the QA program.

FIELD SPECTROMETRY

After they received the site selection forms from DRI, technicians from LLNL or EG&G visited each site to measure the gamma radiation in the soil. The primary measurements were made by *in situ* gamma-ray spectrometry using a germanium detector placed 1 m above the ground. This instrument measured the flux of the 662-keV gamma rays given off by ^{137}Cs. A much higher or (especially) lower Cs flux at a site relative to other sites in the same locality suggests that the site may have been disturbed.

In addition, the *in situ* measurement system recorded a complete spectrum of the gamma-rays given off by Cs and other radionuclides in the soil. Later analysis of the spectrum would help to verify some of the results from the soil samples.

While the gamma-ray spectrum was being recorded, a pressurized ion chamber was used to measure the external gamma exposure rate at the site. The exposure rate measurement served to confirm the results of the *in situ* spectrometry.

These measurements were made at about 75% of the potential sites. The other sites were not measured for one or more of several possible reasons:

1. The site appeared to be subject to flooding, lacked sufficient ground cover, or was otherwise physically unsuitable.
2. Statements of local residents suggested that the site had been disturbed since 1950. (Such statements contradicted earlier statements to the site selection team by other local residents, but a site was rejected if there was any doubt about its age.)
3. The landowner could not be found or would not give permission.
4. Several sites from a locality had already been measured. This was often the case in the cities visited in 1983, as travel schedules often prevented measuring all potential sites.

The Cs inventories computed from the *in situ* measurements are given in Appendix B. These values are only approximate because the computation used a default value for the depth distribution of Cs in the soil. Again, it was the comparison of values at nearby sites that was used to reject some sites as possibly disturbed.

SAMPLE COLLECTION

After the *in situ* measurements were completed, a third team from REECo collected soil samples at most of the suitable sites.

Samples were collected as 8.9-cm-diameter cores of soil, divided into four depth increments. First, a core cutter was used to remove the upper 5 cm of soil, including any sod and roots. Next, longer core cutters were used to remove the 5- to 10-cm and the 10- to 15-cm increments. Finally, a soil auger was used to extract the 15- to 30-cm increment.

Natural sites such as pastures and meadows are usually less heavily irrigated than lawns, so fallout tends to remain closer to the surface. At such sites, the procedure was modified by cutting the top 5 cm core in half to give increments of 0 to 2.5 cm and 2.5 to 5

cm. After the 5- to 10-cm core was removed, the auger was used to remove a 10- to 30-cm core.

To increase the likelihood of getting a representative sample, 10 such soil cores were collected at each site. (Previous work by EML and REECo suggested that collecting 10 cores would give a sampling error of about eight percent.) The respective increments from each core were combined so that after the collection was finished, there were four composite samples, one for each depth increment. Each sample was sealed in a plastic bag, and the four samples were put into a large cloth sack and taken to the REECo Soils Laboratory in Las Vegas.

The sampling team was careful to make sure that soil from the sides of the hole did not fall in and contaminate the lower samples. If this happened, the entire core was abandoned and a new core started. If the soil was loose or sandy, it was often necessary to moisten it before good cores could be removed. At some sites, the soil was too sandy or too rocky to allow good cores to be removed, and these sites were rejected after consultation with the scientific director. If the soil sampling team and the *in situ* measurement team were traveling together, they sometimes chose an alternative site to replace one that had to be rejected.

SAMPLE PREPARATION

The canvas sacks containing the four samples from each site were stored in the receiving area of the Soils Laboratory until they entered the preparation process. At that time, the sacks were opened and the plastic bags containing the samples were removed.

The samples submitted for analysis in 1982-85 had their identifying labels replaced with a laboratory identification number chosen at random by DRI (in its role as the QA referee) from a list of numbers provided by the REECo Analytical Laboratory. From this point until the analysis was complete, the identity of the sample was unknown to the people doing the preparation and analysis. Samples that were not to be analyzed were prepared with their identities preserved and sent to storage.

After numbering, the bags were put on shelves in the receiving area to await processing by the laboratory. Bags were numbered and shelved in large groups, usually 24 at a time, but the order of processing the bags within a group was arbitrary. Often the laboratory would process all the upper-increment samples before starting the much larger fourth-increment bags.

The first step in preparing a sample was to transfer it to one-gallon paint cans, with each can being filled to about one-third full. Any large rocks and roots were removed, and

clumps of grass and roots were cut up into 1/4-inch pieces. The sample was then dried at 105°C for at least 24 hours.

After the sample was dry, 10 steel grinding balls were added to each can. The cans were then covered and placed on a rotating ball mill for three hours. After ball-milling, the soil was sieved to separate the fine (less than 500 micrometers) and coarse fractions. The coarse fraction was ball-milled again for one hour, then sieved. The remaining coarse material was ball-milled and sieved a third time.

Any coarse material remaining after three ball-millings was put in a plastic bottle and stored, as were the empty sample bag and any discarded roots and rocks. The fine fraction was put in one or more one-gallon cans from which aliquots were drawn for analysis. After all the necessary aliquots had been drawn, the cans and bottles were taken to a warehouse at the NTS for storage.

The samples prepared in 1986 and 1987 were not assigned laboratory numbers directly. Instead, the cans and bottles were labeled with the site identifier and increment number, and laboratory numbers were assigned to the aliquots as they were drawn. This modification of the procedure allowed resolution of any questions about the numbering of samples, but it prevented the inclusion of blind QA samples to check for contamination in the preparation lab.

GAMMA SPECTROMETRY

Two 500-ml plastic bottles were filled with fine soil from each sample to be analyzed. The bottles were labeled "A" and "B"; the "A" bottles were sent to the Analytical Laboratory at the NTS, while the "B" bottles were set aside for later use if necessary.

At the Analytical Laboratory, a gamma spectrometer counted the gamma rays of different energies given off by the radionuclides in the soil in each bottle. All bottles were initially counted for 300 minutes. The resulting gamma-ray spectrum was then analyzed by a computer program at EML to determine the specific activities of Cs and several naturally-occurring gamma-emitting radionuclides in the sample.

As the analyses were completed, the results were reported to DRI. Once the data for all four increments at a site had been received, the total inventory of Cs at the site and its coefficient of variation were computed as described in Section 3. If the coefficient of variation for a site was greater than 0.05, at least one of the samples was recounted for 1,000 minutes. (Usually it was the fourth-increment sample that was recounted, as these samples

tended to have low activity and the precision of a 300-minute count was therefore relatively low.) The calculations were then repeated, and additional recounts were made if necessary until the coefficient of variation was less than five percent.

PLUTONIUM ANALYSIS

The high cost of the plutonium analysis prevented analyzing all four increments separately. On the other hand, it was felt that if the four increments were combined into a single sample, the low activity in the large fourth-increment sample would result in low overall precision. As a compromise, each site was analyzed in two fractions, denoted "top" and "bottom." A 200-g sample from the top fraction was prepared from increments 1 and 2 by combining

$$200(w_1)/(w_1 + w_2) \text{ g of soil from increment 1}$$

with

$$200(w_2)/(w_1 + w_2) \text{ g of soil from increment 2,}$$

where w_i is the dry weight of the fine soil from increment i. The respective aliquots were taken from the gallon cans containing the fine soil, with a proportionate amount being taken from each can if a sample occupied more than one. A 200-g sample from the bottom fraction was prepared from increments 3 and 4 by a similar formula.

The 200-g samples were placed in plastic bottles at the soils lab. The bottles were then given a laboratory number at random and sent to the Analytical Laboratory in batches, usually of 10 bottles including at least two QA samples. Several early batches had fewer than 10 samples, and two batches of 25 were sent to EAL Corporation for analysis in August 1985 because the REECo laboratory was down for repairs and the results were needed quickly.

The chemical procedure used to extract the plutonium from the sample was the same one used at EML. The first step was to leach the plutonium from the soil with concentrated nitric and hydrochloric acids. The plutonium was purified and electroplated onto a thin platinum disk, then counted twice for 1,000 minutes each time on an alpha spectrometer. This technique was used to measure the amounts of various plutonium isotopes in the sample: ^{236}Pu (added by the laboratory as a tracer), ^{238}Pu, and the sum of ^{239}Pu and ^{240}Pu. The alpha particles given off by ^{239}Pu and ^{240}Pu have nearly the same energy, and the isotopes therefore cannot be measured individually by alpha spectrometry.

Section 4 describes the QA criteria applied to individual samples and to batches of samples that led to rejection of many analyses. New aliquots were made of rejected samples and submitted in later batches until acceptable results were obtained. In a few cases, the same result was obtained for a sample in three or four different batches even though none of the batches met the QA criteria, and these results were assumed to be correct.

ISOTOPE MASS SPECTROSCOPY

After the plutonium analysis was complete, isotope mass spectroscopy was used to determine the ratios of ^{240}Pu to ^{239}Pu and ^{241}Pu to ^{239}Pu in the sample on the platinum disks. The analysis was done by Pacific Northwest Laboratories according to standard procedures.

SECTION 3
ANALYTICAL RESULTS

CESIUM

Soil samples were collected from 336 sites. After reviewing the site selection and sample collection logs, the supervisory committee chose to have the samples from 213 sites analyzed by gamma spectrometry.

A total of 1,039 bottles of soil were submitted for gamma analysis, with 853 being "A" bottles and 186 being QA samples of various types. The 853 "A" bottles represent the 213 sites, with one site (MH02) having five increments instead of the usual four. Recounts of 208 bottles brought the total number of gamma counts to 1,247.

The Cs data from the 213 sites are reported in this section; the data for the naturally-occurring radionuclides were used for quality assurance and are reported in Section 4. The results reported for each count of a sample were the concentration of Cs (in pCi/g of soil) and a standard deviation (expressed as a percentage of the concentration) based on the counting error. Because ^{137}Cs has a half-life of only 30.2 years, an appreciable amount of radioactive decay would have occurred over the five-year span of the program. To make all of the measurements comparable, they were decay-corrected to 1 January 1983 by the formula

$$Cs(1983) = Cs \text{ in sample } x \exp[(6.284 \times 10^{-5})t],$$

where t is the number of days between 1 January 1983 and the date the sample was counted. The decay-corrected values were used in all subsequent calculations.

The first step in computing the total inventory at a site was to compute a variance-weighted average value for samples that were counted more than once. First the variance of each count was calculated from the reported standard deviation:

$$v_{ij} = [C_{ij} \times \%sd_{ij}/100]^2,$$

where C_{ij} is the result of count j of the sample from increment i and $\%sd_{ij}$ is the standard deviation (percent) of C_{ij}. Then the average and its standard deviation were computed from the equations

$$C_i = \frac{\sum_{j=1}^{n_i} \frac{C_{ij}}{v_{ij}}}{\sum_{j=1}^{n_i} \frac{1}{v_{ij}}}$$

$$s_i = \sqrt{\frac{1}{\sum_{j=1}^{n_i} \frac{1}{v_{ij}}}} \quad ,$$

where n_i is the number of counts of the sample from increment i.

Next, the inventory for each increment (in nCi/m² or mCi/km²) was computed:

$$Cs_i = \frac{10 \times C_i \times w_i}{621}$$

$$sd_i = \frac{10 \times s_i \times w_i}{621} \quad ,$$

where w_i is the dry weight of the sample and 621 is the total area in cm² of the 10 soil cores at each site. At some sites, the auger used to collect the fourth-increment sample had a larger diameter (9.4 cm) than the core cutters (8.9 cm). Samples taken with the larger auger thus represented an area of 69.4 cm² instead of the 62.1 cm² represented by all the other samples. To correct for the difference in areas, the dry weights of the large-auger samples were multiplied by 621/694 = 0.89 whenever they were used in the calculations.

Finally, the total inventory at the site was found by adding the inventories in the four increments (five increments for MH02):

$$Cs_T = \sum_i Cs_i$$

$$sd_T = \sqrt{\sum_i sd_i^2}$$

If the coefficient of variation of the total inventory (C.V. = Cs_T/sd_T) was greater than 0.05, one or more samples were recounted as noted in Section 2.

Table 1 gives the cesium inventory in the four increments and the total inventory at each site. The values of C_i, $\%sd_i$, and w_i from which the inventories were computed are given in Appendix C.

Figure 2 is a histogram of the total inventories at the 213 sites. This figure provides a convenient graphical summary of the numbers in Table 1, although it must be emphasized that the total inventory values are of limited usefulness by themselves. Large variations in the deposition of global fallout over the study area (primarily due to differences in latitude and amounts of rainfall) make it difficult to draw any conclusions from site-to-site variations in total inventory.

The standard deviations given in Table 1 were computed from the standard deviations reported with each count, which were based solely on the counting error, *i.e.*, the variability induced by the random nature of radioactive decay. The total analytical error of the Cs analyses includes the counting error and errors from other sources, such as standardization for counter efficiency and the positioning of the sample on the detector. According to Essington (1988), the minimum analytical error, excluding counting error, at the REECo laboratory is 9 percent due to sample density variability and 1.4 percent due to other sources of variability. However, the EML analysis of the spectra includes a correction for sample density.

An additional source of variation in the Cs analyses is the preparation of aliquots of the sample for gamma-counting. Section 4 will present data from two aspects of the QA program that enable the aliquot-to-aliquot variability to be assessed. The analyses of 55 pairs of duplicate aliquots generally agreed within about 10 percent except in the case of some low-activity samples. In addition, the results of 70 counts of 27 separate aliquots of a standard soil from Hurricane, Utah, had an overall variability of about 5 percent, while the individual counting errors ranged from 2.9 percent to 3.4 percent. Thus the true variability of the Cs analyses is probably only slightly larger than the reported counting errors.

The computed inventories (both Cs and Pu) are the product of a constant times the radionuclide concentration times the weight of the sample, so variability in the measured sample weights also contributes to the uncertainty of the inventory estimates. The magnitude of the weighing error is difficult to assess because different balances were used at

TABLE 1. COMPUTED ^{137}Cs INVENTORIES (nCi/m^2)

Site	Location	Level 1		Level 2		Level 3		Level 4		Total	
		Cs	sd	Cs	sd	Cs	sd	Cs	sd	Cs	sd
AF01	Talmage, UT	21 7	63	30 6	95	12 4	71	11 3	2 06	76 0	2 45
AF02	Ashley N F, UT	64 2	77	75 3	59	43 4	1 09	4 2	1 29	187 2	1 94
AF05	Talmage, UT	13 6	53	22 6	88	13 0	71	21 4	2 25	70 6	2 57
AF14	Mountain Home, UT	10 8	32	12 0	18	25 5	89	30 1	2 47	78 4	2 65
AQ01	Albuquerque, NM	12 8	48	22 6	93	12 7	70	13 1	2 04	61 2	2 39
AQ02	Albuquerque, NM	16 3	50	20 8	90	9 7	77	8 9	1 99	55 7	2 37
AQ03	Albuquerque, NM	11 8	38	29 2	1 11	8 9	81	7 7	2 31	57 6	2 71
AQ04	Albuquerque, NM	18 4	74	22 1	1 02	5 5	64	4 3	1 76	50 3	2 25
AQ05	Albuquerque, NM	20 0	64	17 1	86	6 0	61	8 2	1 67	51 4	2 08
AQ06	Albuquerque, NM	14 0	49	23 2	95	11 5	75	13 2	2 43	61 9	2 76
AQ07	Albuquerque, NM	14 4	47	35 4	99	9 0	75	8 3	2 18	67 0	2 56
AQ08	Albuquerque, NM	14 0	44	40 1	1 12	10 5	73	8 5	2 29	73 2	2 69
AQ09	Albuquerque, NM	5 5	28	36 5	91	11 4	67	8 8	2 05	62 3	2 36
AQ10	Albuquerque, NM	15 9	63	19 7	91	7 5	75	6 0	1 97	49 1	2 38
AQ11	Albuquerque, NM	19 1	69	19 7	1 01	8 9	83	9 7	2 04	57 5	2 52
AQ12	Albuquerque, NM	12 5	59	22 2	93	12 7	84	8 0	1 58	55 4	2 10
AQ13	Albuquerque, NM	14 0	60	25 4	1 01	14 6	83	7 1	1 75	61 0	2 27
AQ14	Albuquerque, NM	16 4	61	22 8	1 00	11 0	89	12 1	1 83	62 3	2 35
AQ15	Albuquerque, NM	9 1	41	17 6	79	16 4	87	11 0	1 89	54 0	2 26
AQ16	Albuquerque, NM	25 3	53	22 3	96	9 2	74	4 1	1 55	60 9	2 04
AQ17	Albuquerque, NM	20 3	71	19 0	95	7 4	71	2 0	1 58	48 7	2 10
AQ18	Albuquerque, NM	26 0	68	18 9	89	7 8	76	3 4	2 04	56 1	2 45
AQ19	Albuquerque, NM	14 4	60	22 1	1 02	18 6	1 02	22 0	2 51	77 1	2 95
AQ20	Albuquerque, NM	11 8	53	19 7	91	12 6	84	8 0	2 29	52 2	2 65
AQ21	Albuquerque, NM	9 0	54	15 5	95	12 4	82	22 6	2 58	59 5	2 91
AQ22	Albuquerque, NM	8 1	60	9 8	91	4 0	68	1 7	1 92	23 5	2 31
AQ23	Albuquerque, NM	33 3	76	18 2	91	3 8	63	2 0	1 95	57 2	2 37
AQ24	Albuquerque, NM	14 4	56	21 3	96	9 1	78	7 9	1 36	52 6	1 92
AQ25	Albuquerque, NM	4 9	38	13 9	96	13 7	85	17 0	2 09	49 5	2 48
AQ26	Albuquerque, NM	7 9	35	19 8	81	15 8	79	18 8	2 36	62 2	2 64
AQ27	Albuquerque, NM	22 1	44	35 8	1 18	4 2	74	1 6	2 37	63 7	2 78
AQ28	Albuquerque, NM	20 2	65	32 3	1 06	12 3	70	10 5	2 01	75 3	2 47
AQ29	Albuquerque, NM	25 3	63	22 6	95	7 9	77	4 7	2 24	60 6	2 63
AQ30	Albuquerque, NM	6 7	48	5 9	58	5 1	72	5 8	2 10	23 5	2 34
AQ31	Albuquerque, NM	10 7	47	18 2	82	11 2	66	15 4	2 21	55 6	2 49
AQ32	Albuquerque, NM	12 3	48	25 1	93	12 3	74	5 7	1 87	55 4	2 26
AQ33	Albuquerque, NM	5 8	27	43 1	90	11 4	82	10 6	2 31	70 8	2 63
AS01	Farmington, NM	14 9	31	14 1	69	18 1	72	23 1	1 39	70 2	1 74
AS06	Cortez, CO	18 5	70	21 0	84	21 3	1 00	19 9	2 39	80 8	2 81
AS08	Mancos, CO	25 2	78	32 4	1 04	16 5	84	11 0	2 29	85 0	2 76
AS10	Durango, CO	24 3	88	27 4	1 04	16 3	91	19 4	2 06	87 4	2 63
AS13	Silverton, CO	34 0	82	45 8	1 10	11 9	43	30 5	1 46	122 2	2 05
AS20	Montrose, CO	24 9	82	19 4	97	8 8	87	11 7	1 41	64 8	2 09
AS21	Fruita, CO	23 5	80	23 0	52	11 2	88	12 7	83	70 4	1 54
AS26	Meeker, CO	21 4	58	38 7	1 08	20 4	84	18 6	1 67	99 1	2 24
AS27	Craig, CO	57 8	98	25 8	1 11	7 0	85	7 0	2 14	97 6	2 74
AS28	Craig, CO	35 5	85	35 7	1 21	14 9	36	15 5	2 30	101 6	2 76
AS32	Rock Springs, WY	17 7	62	24 3	95	18 2	82	16 4	1 92	76 7	2 38
AS35	Evanston, WY	25 2	54	15 6	93	8 2	75	11 0	1 42	59 9	1 94
AS36	Kemmerer, WY	39 0	28	22 3	39	8 3	81	10 1	2 63	79 7	2 79
AS41	Afton, WY	29 1	76	33 3	87	15 9	62	20 7	1 57	98 9	2 04
AS43	Idaho Falls, ID	24 6	76	37 4	1 16	24 8	56	9 7	1 91	96 5	2 43
AS50	Pocatello, ID	32 8	85	37 8	79	21 0	94	14 4	2 29	106 0	2 74
BA03	Seattle, WA	17 4	45	31 2	91	14 6	67	10 2	1 27	73 5	1 76
BA11	Medford, OR	15 4	49	18 7	77	5 9	60	3 2	1 32	43 1	1 71
BA13	San Francisco, CA	9 3	39	17 7	76	11 4	64	6 9	97	45 2	1 44
BA15	San Francisco, CA	10 5	49	20 0	86	9 1	65	4 6	1 00	44 2	1 55
BA18	Long Beach, CA	11 8	32	13 0	50	3 9	30	2 5	93	31 2	1 15
BA29	Los Angeles, CA	10 6	26	17 1	89	7 9	71	5 2	1 07	40 8	1 58
BA30	Los Angeles, CA	10 3	28	12 4	82	7 1	39	6 5	1 27	36 4	1 59
BE01	Furnace Creek, CA	12 8	54	23 5	87	11 2	48	13 5	1 45	61 0	1 84
BE06	Shoshone, CA	11 6	33	21 3	89	10 6	77	5 6	99	49 0	1 57
BE09	Bullhead City, AZ	14 1	65	12 4	33	6 9	78	0 9	1 47	34 2	1 81
BE10	Indian Springs, NV	13 8	52	18 3	82	6 9	68	6 3	1 11	45 3	1 62
BE22	Bishop, CA	10 6	29	12 8	28	9 4	76	6 8	98	39 7	1 30
BE25	Independence, CA	7 4	18	8 8	24	8 4	39	11 1	1 31	35 7	1 40
BE29	China Lake, CA	6 8	21	5 8	24	3 6	28	2 9	58	19 1	72
BE32	Beatty, NV	17 1	55	9 3	45	6 7	44	3 1	1 45	36 2	1 67
BE34	Carver's, NV	5 3	30	6 3	36	28 6	97	22 1	3 14	62 4	3 32
BE37	Alamo, NV	15 9	59	22 4	94	14 5	41	13 3	1 18	66 1	1 67
BE38	Alamo, NV	11 4	23	17 3	88	7 5	40	6 1	1 33	42 3	1 66
BE39	Alamo, NV	13 2	57	17 7	88	10 1	63	12 8	2 01	53 7	2 34
BE40	Alamo, NV	8 6	46	18 1	94	14 5	84	20 4	2 04	61 6	2 45
BF01	Bluebell, UT	10 1	22	13 0	39	37 2	1 23	50 7	3 40	111 1	3 64
BF03	Arcadia, UT	21 5	56	34 3	1 27	16 0	91	17 5	2 36	89 2	2 89
BF05	Altonah, UT	17 7	57	21 9	88	12 2	72	12 1	1 65	63 8	2 08
BF09	Altonah, UT	7 2	26	6 3	21	32 4	1 00	22 7	2 82	68 6	3 01
BF10	Duchesne, UT	23 4	77	12 9	91	7 0	82	6 7	1 19	50 0	1 88
BF13	Riverton, WY	22 9	83	21 6	97	15 8	82	11 4	2 36	71 7	2 81
BF15	Rawlins, WY	19 0	65	22 4	78	17 6	67	20 6	1 87	79 6	2 23
BF19	Upalco, UT	22 7	52	38 1	1 03	7 8	53	5 4	50	74 0	1 36
BF22	Bluebell, UT	22 3	58	23 3	72	10 5	69	1 0	1 40	57 2	1 82
DZ01	Baker, NV	28 3	37	21 2	52	14 5	80	14 4	2 08	78 3	2 32
DZ04	Ely, NV	41 6	75	28 2	41	12 1	49	6 8	1 08	88 7	1 46
DZ4A	Ely, NV	33 9	54	16 7	45	3 4	59	2 3	96	56 3	1 33
DZ05A	Ely, NV	19 8	32	28 1	64	23 5	52	16 3	1 37	87 6	1 63
DZ09A	McGill, NV	63 6	89	7 9	60	1 8	59	3 8	1 90	77 2	2 26
DZ10	Ibapah, UT	47 5	57	27 3	42	7 2	71	4 1	1 97	86 2	2 21
DZ16	Wendover, UT	28 3	52	18 3	70	14 1	40	13 9	1 50	74 5	1 78
DZ18	Tooele, UT	27 1	71	40 1	1 08	27 8	1 00	20 7	2 24	115 8	2 77
DZ21	Iosepa, UT	26 3	74	34 4	1 07	19 4	78	22 7	1 65	102 9	2 24
EML3	St George, UT	14 5	44	33 1	93	22 6	90	10 1	1 13	80 3	1 77
E20A	Kanab, UT	15 7	40	26 2	64	16 2	53	13 9	1 56	72 0	1 81
E26A	Parowan, UT	22 0	71	37 5	1 01	23 9	91	18 5	1 72	101 9	2 30
E35	Cedar City, UT	14 7	38	23 4	46	15 1	53	14 7	1 13	67 8	1 38
E132	Vernal, UT	21 9	72	20 6	97	11 6	78	13 9	2 54	68 0	2 92

TABLE 1. COMPUTED ^{137}Cs INVENTORIES (nCi/m^2) (continued)

Site	Location	Level 1		Level 2		Level 3		Level 4		Total	
		Cs	sd	Cs	sd	Cs	sd	Cs	sd	Cs	sd
FM01	Kingman, AZ	26 1	55	9 2	49	5 6	96	11 3	1 43	52 3	1 87
FM08	Grand Canyon, AZ	14 0	27	24 9	50	31 6	1 01	20 7	2 76	91 2	2 99
FM10	Grand Canyon, AZ	21 5	47	19 1	46	21 4	90	10 7	1 96	72 7	2 25
FM14	Tuba City, AZ	9 7	54	21 5	99	15 7	77	7 8	1 80	54 7	2 26
FM16	Gallup, NM	45 4	95	14 9	83	4 9	69	8 9	2 92	74 1	3 26
FM17	Holbrook, AZ	14 4	56	19 5	74	12 4	63	14 2	2 23	60 6	2 50
FM29	Ganado, AZ	30 1	87	16 4	90	8 5	81	6 1	1 46	61 0	2 09
FM31	Albuquerque, NM	30 0	75	13 4	78	7 1	77	8 1	1 17	58 7	1 77
FM32	Albuquerque, NM	20 6	66	20 8	96	11 8	95	9 4	2 60	62 6	3 00
FM33	Albuquerque, NM	16 6	47	39 9	70	13 3	89	16 0	2 87	85 9	3 12
FM33R	Albuquerque, NM	15 6	48	38 2	1 03	15 3	97	12 1	3 05	81 3	3 40
FM34	Albuquerque, NM	12 3	42	38 9	1 01	10 2	83	12 3	2 77	73 6	3 10
FM35	Albuquerque, NM	21 5	54	27 4	90	12 0	79	9 3	2 87	70 2	3 16
FM35R	Albuquerque, NM	21 0	57	27 7	94	10 4	80	12 0	3 00	71 2	3 29
FM39	Chinle, AZ	24 7	82	25 0	93	11 2	82	13 9	2 45	74 9	2 87
FM43	Williams, AZ	51 6	93	28 7	92	15 1	44	10 9	1 74	106 4	2 22
FM45	Flagstaff, AZ	21 0	65	26 9	66	17 5	82	17 0	2 42	82 4	2 72
FM46	Flagstaff, AZ	69 5	1 04	6 9	65	3 0	67	1 3	1 73	80 8	2 23
FM50	Flagstaff, AZ	48 6	1 02	5 6	76	17 6	88	0 9	2 84	72 8	3 24
FM54	Fort Defiance, AZ	16 2	38	13 4	48	7 2	43	7 0	1 33	43 7	1 52
GC05	Reno, NV	13 4	23	15 6	41	8 8	94	9 2	1 50	47 0	1 83
GC06	Reno, NV	18 8	56	16 6	47	4 0	48	4 5	1 04	43 9	1 36
GC08	Gerlach, NV	16 0	53	25 8	85	20 3	79	30 0	2 55	92 1	2 85
GC10	Lovelock, NV	15 9	52	15 6	53	10 5	66	16 0	2 31	58 1	2 51
GC12	Lovelock, NV	23 8	29	13 1	66	9 3	71	4 5	1 32	50 8	1 66
GC15	Fallon, NV	13 0	56	19 1	94	17 6	90	13 8	2 39	63 6	2 78
GC19	Gabbs, NV	10 0	40	33 2	90	20 1	81	4 8	1 20	68 1	1 75
GC20	Austin, NV	22 0	57	35 7	96	9 2	75	12 0	1 46	78 8	1 99
GC23	Austin, NV	16 1	37	19 4	45	47 3	1 32	26 4	3 17	109 2	3 48
GC29	Bridgeport, CA	23 3	63	44 7	1 03	9 6	81	2 9	2 44	80 5	2 84
GC33	Hawthorne, NV	35 4	96	8 4	44	3 5	87	4 4	1 36	51 7	1 92
GC39	Yerington, NV	21 4	36	12 7	47	4 0	79	4 8	1 39	43 0	1 70
GC43	Gardnerville, NV	11 7	24	16 4	76	11 5	75	10 4	1 24	50 1	1 65
GC48	Stewart, NV	16 1	50	23 7	83	15 0	53	8 8	2 08	63 6	2 35
GC50	Moores Station, NV	22 6	66	26 6	1 15	3 7	73	2 7	1 09	55 7	1 86
KM01	Memphis, TN	14 4	35	18 7	97	14 9	94	15 5	1 56	63 5	2 09
KM06	Memphis, TN	34 3	72	55 5	1 28	22 1	97	9 8	2 47	121 7	3 03
KM13	Dallas, TX	37 9	87	17 4	61	5 7	47	6 3	1 83	67 2	2 16
KM18	Corpus Christi, TX	17 6	41	17 6	77	2 1	23	3 5	1 07	40 8	1 40
KM21	Corpus Christi, TX	11 5	37	22 9	54	8 2	67	3 7	1 15	46 3	1 48
KM28	Tucson, AZ	16 6	70	30 5	1 13	5 3	76	2 3	1 32	54 8	2 02
KM29	Tucson, AZ	20 5	57	12 7	48	3 2	40	1 2	1 05	37 6	1 35
KM33	Tucson, AZ	12 4	57	15 5	44	8 1	34	7 5	1 32	43 5	1 54
KS01	Fredonia, AZ	21 8	70	30 6	66	14 0	43	13 9	1 42	80 3	1 77
KS05	Grand Canyon, AZ	113 0	1 13	9 9	64	3 9	77	8 2	1 87	135 1	2 41
KS07	Moccasin, AZ	13 8	44	29 9	90	15 4	74	7 0	1 64	66 1	2 06
KS10	Grand Canyon, AZ	88 5	71	28 0	24	10 5	60	6 6	1 09	133 5	1 45
KS21	Littlefield, AZ	29 0	90	35 3	1 13	24 3	97	31 5	2 14	120 1	2 76
KS24	Mesquite, NV	22 1	75	25 1	93	17 5	94	16 1	1 50	80 7	2 14
KS25	Bunkerville, NV	31 0	81	50 7	86	44 3	61	34 2	2 57	160 3	2 89
KS26	Bunkerville, NV	52 0	55	59 5	1 05	25 8	1 06	18 4	2 01	155 8	2 56
KS27	Logandale, NV	8 6	34	11 7	36	11 2	61	11 0	1 08	42 6	1 34
KS30	Overton, NV	22 2	66	19 3	44	10 5	55	11 0	2 68	62 9	2 85
KS33	Alamo, NV	11 0	54	14 1	86	10 4	79	8 4	1 04	43 9	1 65
KS34	Alamo, NV	8 2	55	12 4	78	13 3	90	29 0	2 44	62 9	2 77
KS36	Hiko, NV	16 0	69	17 5	88	15 6	81	11 9	1 44	61 1	2 00
MH02	Rosette, UT	14 1	31	32 7	49	84 9	1 44	22 6	93	170 4	3 55
MH03	Snowville, UT	76 4	76	22 0	51	15 7	88	15 6	2 65	129 7	2 94
MH07	Malad City, ID	33 7	52	26 4	48	16 1	64	13 0	1 04	89 1	1 41
MH11	Burley, ID	18 5	70	17 4	73	22 6	93	9 8	2 10	68 4	2 51
MH12	Burley, ID	27 2	46	34 1	58	16 3	80	2 1	1 01	79 6	1 49
MH14	Twin Falls, ID	22 8	68	34 0	77	16 3	90	8 7	1 10	81 7	1 75
MH17	Twin Falls, ID	25 7	87	21 3	98	13 0	90	10 7	1 14	70 7	1 96
MH19	Meridian, ID	35 3	85	12 8	77	7 1	72	7 2	98	62 5	1 67
MH22	Boise, ID	53 7	59	14 4	61	4 7	52	3 0	68	75 8	1 21
MH25	Jordan Valley, OR	30 7	65	24 5	46	13 3	66	11 9	93	80 4	1 39
MH28	Hines, OR	19 7	51	25 9	75	9 8	36	8 0	1 51	63 4	1 80
MH29	Basque Station, OR	20 6	64	28 6	89	18 2	78	13 7	2 20	80 9	2 58
NM01	Estancia, NM	9 1	44	17 7	74	16 6	70	41 9	2 39	85 3	2 63
NM02	Moriarty, NM	53 2	1 01	11 4	98	1 6	69	-1 6	2 51	64 6	2 96
NM03	Belen, NM	14 9	58	18 0	1 06	5 8	37	7 3	1 41	46 0	1 90
NM04	Las Cruces, NM	11 1	62	10 2	94	4 0	39	2 2	1 29	27 5	1 75
NM05	Solomonville, AZ	12 1	51	17 1	82	7 4	51	5 1	1 67	41 7	2 00
NM06	Roswell, NM	14 9	51	26 2	1 00	8 4	71	6 2	2 19	55 6	2 56
NM07	Safford, AZ	7 4	37	17 4	89	11 9	75	7 5	1 31	44 2	1 79
NM08	Silver City, NM	14 4	62	22 2	95	12 3	77	13 7	2 58	62 5	2 92
NM09	Socorro, NM	11 3	57	14 4	86	8 5	64	11 6	1 27	45 8	1 76
NM10	Carlsbad, NM	10 0	40	14 9	71	7 0	31	1 4	93	33 3	1 28
NM11	Portales, NM	14 9	60	25 5	1 02	18 5	90	13 1	2 52	72 0	2 93
NM12	Tucumcari, NM	12 3	53	19 7	81	15 6	78	42 3	2 62	89 9	2 90
NM13	Socorro, NM	10 3	44	20 2	93	6 3	30	4 7	1 00	41 5	1 46
NM14	Sante Fe, NM	26 1	63	23 2	83	8 6	58	7 6	1 82	65 5	2 17
NM15	Sante Fe, NM	24 8	59	11 2	63	5 6	54	3 9	1 36	45 5	1 70
NM16	Sante Fe, NM	19 8	73	18 5	96	8 0	60	8 2	1 86	54 4	2 30
NM17	Raton, NM	50 9	81	13 1	81	7 3	71	7 0	1 93	78 3	2 36
NM18	Cimarron, NM	14 3	54	23 4	96	18 3	91	18 6	2 47	74 5	2 86
NM19	Chama, NM	40 1	80	21 2	87	9 9	74	14 0	2 16	85 3	2 57
NM20	Farmington, NM	16 7	65	25 4	1 09	14 8	75	13 3	1 17	70 2	1 89
NM21	Farmington, NM	22 4	56	13 3	80	5 5	66	5 0	1 56	46 2	1 95
NM22	Farmington, NM	13 9	45	18 9	94	10 3	77	14 8	2 35	57 8	2 68
NM23	Tempe, AZ	4 5	43	12 5	83	9 3	78	6 7	1 42	33 0	1 87
NM24	Tempe, AZ	5 7	40	9 1	76	14 3	86	7 3	1 36	36 4	1 82
NM25	Mesa, AZ	13 1	72	15 0	93	8 2	81	5 5	1 51	41 8	2 07
NM26	Litchfield Park, AZ	6 3	49	10 0	73	6 3	36	5 1	1 20	27 7	1 53
RB01	Scottsbluff, NE	28 2	85	33 6	83	21 4	1 00	9 2	2 25	92 3	2 74
RB08	Rapid City, SD	31 4	85	44 5	1 25	36 2	1 16	70 9	3 26	183 0	3 77

TABLE 1 COMPUTED ^{137}Cs INVENTORIES (nCi/m^2) (continued)

Site	Location	Level 1		Level 2		Level 3		Level 4		Total	
		Cs	sd	Cs	sd	Cs	sd	Cs	sd	Cs	sd
RB11	Rapid City, SD	17 3	45	18 8	49	36 1	1 12	126 8	4 18	199 0	4 38
RB16	Billings, MT	48 2	1 06	19 2	90	13 8	89	11 9	2 28	93 1	2 82
RM02	Winnemucca, NV	29 0	75	20 8	92	8 9	60	9 7	1 09	68 5	1 72
RM06	Battle Mountain, NV	28 6	89	21 9	97	8 6	84	5 1	1 16	64 2	1 94
RM08	Carlin NV	64 4	84	8 2	50	2 1	61	3 0	1 70	77 7	2 05
RM10	Elko, NV	19 5	54	22 4	99	16 4	84	15 6	1 95	74 0	2 40
RM12	Wells, NV	42 0	97	15 8	89	8 7	83	13 1	1 49	79 6	2 15
RM14	Pioche, NV	13 0	46	31 9	1 08	13 6	1 19	5 0	1 94	63 4	2 56
RM19	Panaca, NV	12 4	32	16 6	40	15 5	1 05	20 0	2 34	64 4	2 62
RM21	Caliente, NV	23 1	78	21 3	91	8 4	95	4 5	1 13	57 2	1 91
SA02	Wichita, KS	18 2	54	33 5	1 04	23 5	94	21 5	2 45	96 7	2 87
SA07	Wichita, KS	37 4	90	23 2	90	13 2	75	13 2	1 90	87 0	2 41
SA19	Des Moines, IA	29 7	86	41 7	1 21	20 7	91	21 2	2 12	113 3	2 74
SA20	St Louis, MO	24 4	73	39 2	1 14	18 5	83	23 7	2 39	105 8	2 87
SA26	St Louis, MO	32 7	95	40 3	1 17	25 8	1 03	24 1	2 31	122 9	2 95
SH05	Las Vegas, NV	16 3	54	12 7	76	5	51	8	93	30 3	1 42
SH07	Las Vegas, NV	5 9	29	20 0	90	9 6	72	4 7	70	40 2	1 38
SH10	Henderson, NV	13 7	51	13 9	35	1 7	69	4 3	1 31	33 6	1 60
SH11	Boulder City, NV	11 6	47	16 4	72	5 4	66	2 5	90	35 9	1 41
SW02	Lund, NV	16 5	64	24 9	1 05	15 4	80	15 7	2 24	72 5	2 68
SW03	Preston, NV	26 3	82	24 3	92	12 8	82	13 5	2 54	77 0	2 94
SW05	Eureka, NV	51 9	62	14 5	41	3 9	31	2 0	93	72 3	1 23
SW06	Duckwater, NV	23 8	45	24 0	43	21 7	87	2 7	2 39	72 1	2 62

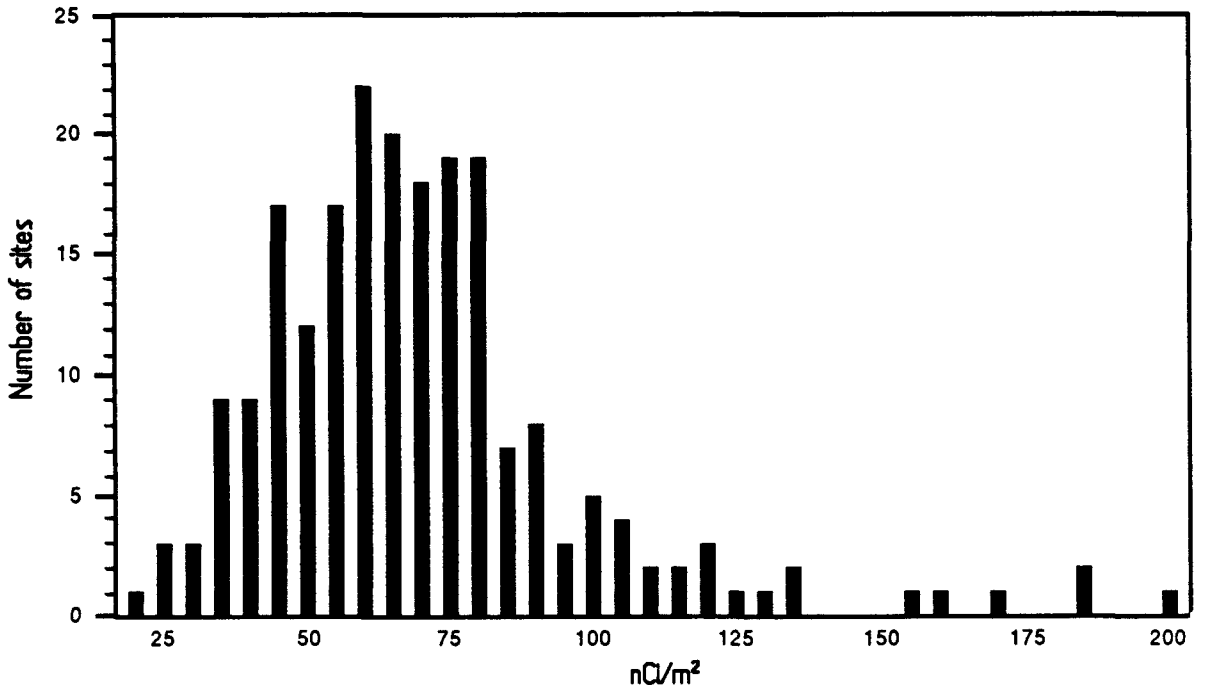

Figure 2 Histogram of total ^{137}Cs inventories

different steps of the processing. In addition, anywhere from 10 to 30 or more separate weighings of samples and cans and several additions and subtractions were needed to arrive at the dry weight of the fine fraction of a single sample, providing numerous opportunities for errors in transcription and arithmetic.

A close inspection of the preparation process in mid-1984 revealed that at least one of the balances had a bias of several grams and that the forms on which the weights were recorded contained only the net soil weights, not the raw data. At this point, new forms were designed, all calculations were checked, and all cans of fine soil, bottles of coarse material and bags and debris, and any subsamples that had been drawn were reweighed. The weights calculated during the reweighing effort were almost always within 25 g of the original weights. A few discrepancies on the order of 200 g did occur, but these were associated with fourth-increment samples weighing more than 10 kg. Errors of this magnitude in the sample weights have a negligible effect on the precision of the computed inventories.

PLUTONIUM

After a sufficiently precise Cs inventory had been obtained for a site, another evaluation was made. Sites at which Cs did not decrease with depth or at which the natural radioactivity in the four increments was unusually variable (suggesting that the site may have been disturbed) were often rejected at this stage. Other sites were not analyzed further because of budgetary and time constraints.

A total of 671 aliquots were analyzed for Pu. Of these, 342 represent the two increments from the 171 sites chosen for Pu analysis. The others include QA samples and aliquots for which the analytical results were rejected on the basis of the QA criteria.

The plutonium results were reported in units of disintegrations per minute per gram (dpm/g) with a standard deviation in percent. The inventory computations were similar to those for cesium, beginning with the calculation of a variance-weighted average of the results from the two or more counts of each disk. This average was then multiplied by a correction factor intended to compensate for the incorrect aliquoting of the early samples. Many of these aliquots had been prepared using the total dry weight of the samples (including the coarse material) instead of the dry weight of the fine fraction. The only way to correct this error completely would have been to recomposite and reanalyze the samples, which was deemed too expensive. However, an approximate correction factor was

derived from the cesium data under the assumption that the cesium and plutonium had the same distribution in the soil column.

The correction factor for the top level was computed as follows:

old effective activity = $[aw_1 \times C_1 + (200 - aw_1) \times C_2]/200$ where aw_1 is the weight (possibly incorrect) of the aliquot from increment 1,

new effective activity = $[w_1 \times C_1 + w_2 \times C_2]/(w_1 + w_2)$,

correction factor = new effective activity / old effective activity.

The correction factor for the bottom level was similar, with w_4 adjusted for the auger size if necessary. These correction factors were relatively small, ranging from 0.97 to 1.14. Note that the correction factor was 1 if the aliquots were prepared correctly.

The inventory in each of the two levels was then computed as

$$Pu_i = \frac{10 \times P_i \times (w_j + w_k)}{(621 \times 2.2)}$$

$$sd_i = \frac{Pu_i \times \%sd_i}{100} \quad ,$$

where P_i is the corrected average Pu value for the aliquot from level i, i = 1 or 2; $\%sd_i$ is the standard deviation of P_i ; and j = 1, k = 2 when i = 1; j = 3, k = 4 when i = 2. The total plutonium inventory was then

$$Pu_T = Pu_1 + Pu_2$$

$$sd_T = \sqrt{(sd_1^2 + sd_2^2)}$$

Table 2 gives the Pu inventories for the 171 sites. The two results given for site AQ16 are based on analysis of two separate aliquots of the sample from the top increment at that site. Figure 3 shows the distribution of all the computed inventories except those from AQ16. The values of P_i and $\%sd_i$ are given in Appendix C.

As with the Cs inventories, the total Pu inventories by themselves are of limited value, both because of variations in the deposition of global fallout and because the leach-

TABLE 2. COMPUTED $^{239+240}$Pu INVENTORIES (nCi/m^2)

Site	Location	Top		Bottom		Total		
		Pu	sd	Pu	sd	Pu	sd	Cs/Pu
AF01	Talmage, UT	1 7	06	9	05	2 6	08	29
AF05	Talmage, UT	1 2	05	1 1	08	2 3	09	31
AF14	Mountain Home, UT	6	03	1 8	13	2 4	13	32
AQ01	Albuquerque, NM	8	04	4	03	1 2	05	50
AQ02	Albuquerque, NM	8	04	6	04	1 4	05	40
AQ03	Albuquerque, NM	9	04	4	04	1 3	06	45
AQ04	Albuquerque, NM	2 4	09	3	03	2 7	09	19
AQ05	Albuquerque, NM	3 7	11	9	05	4 7	12	11
AQ06	Albuquerque, NM	2 5	11	1 0	06	3 5	12	18
AQ07	Albuquerque, NM	7 4	27	1 2	06	8 7	27	8
AQ08	Albuquerque, NM	3 6	12	9	06	4 6	13	16
AQ09	Albuquerque, NM	4 5	16	1 2	06	5 6	17	11
AQ10	Albuquerque, NM	9	04	3	03	1 2	04	41
AQ11	Albuquerque, NM	9	04	4	03	1 3	05	45
AQ12	Albuquerque, NM	8	03	5	03	1 3	05	43
AQ13	Albuquerque, NM	9	03	8	06	1 6	07	37
AQ14	Albuquerque, NM	9	05	6	06	1 5	08	40
AQ15	Albuquerque, NM	6	03	6	04	1 2	05	44
AQ16	Albuquerque, NM	16 2	73	5 1	19	21 3	75	3
AQ16	Albuquerque, NM	4 9	19	(5 1	19)	10 0	27	6
AQ17	Albuquerque, NM	9	04	3	02	1 2	05	42
AQ18	Albuquerque, NM	9	04	4	04	1 3	05	42
AQ19	Albuquerque, NM	8	04	1 0	06	1 8	07	42
AQ20	Albuquerque, NM	7	04	5	04	1 2	05	42
AQ21	Albuquerque, NM	5	03	8	05	1 3	05	45
AQ22	Albuquerque, NM	5	02	2	02	6	03	39
AQ23	Albuquerque, NM	1 2	06	4	04	1 5	07	37
AQ24	Albuquerque, NM	1 1	05	4	03	1 5	06	35
AQ25	Albuquerque, NM	1 5	07	2 3	11	3 8	13	13
AQ26	Albuquerque, NM	6	03	8	04	1 4	05	45
AQ27	Albuquerque, NM	1 1	05	2	03	1 3	06	49
AQ28	Albuquerque, NM	1 0	04	5	04	1 5	06	51
AQ29	Albuquerque, NM	1 0	05	4	03	1 4	06	44
AQ30	Albuquerque, NM	3	03	3	03	6	05	41
AQ31	Albuquerque, NM	7	04	1 2	09	1 9	10	29
AQ32	Albuquerque, NM	8	04	4	04	1 2	06	46
AQ33	Albuquerque, NM	3 6	16	1 2	08	4 8	18	15
AS06	Cortez, CO	1 9	06	1 2	07	3 0	09	27
AS10	Durango, CO	1 2	05	7	04	1 9	06	46
AS13	Silverton, CO	1 8	06	1 0	04	2 8	07	44
AS21	Fruita, CO	1 2	04	7	04	1 8	06	38
AS26	Meeker, CO	1 5	07	1 1	07	2 6	10	38
AS27	Craig, CO	1 9	07	3	02	2 2	07	45
AS32	Rock Springs, WY	1 2	05	1 2	05	2 4	07	32
AS35	Evanston, WY	1 0	04	1 1	06	2 1	07	29
AS36	Kemmerer, WY	1 4	05	4	03	1 8	06	45
AS41	Afton, WY	1 6	06	1 1	05	2 7	07	37
AS43	Idaho Falls, ID	1 3	05	7	05	2 0	07	48
AS50	Pocatello, ID	1 5	05	9	04	2 4	07	44
BA03	Seattle, WA	1 0	04	5	03	1 5	05	49
BA11	Medford, OR	8	03	3	02	1 1	04	41
BA15	San Francisco, CA	6	02	2	02	8	03	54
BA29	Los Angeles, CA	7	04	2	02	9	04	46
BA30	Los Angeles, CA	5	02	3	02	8	03	48
BE01	Furnace Creek, CA	1 3	05	1 0	05	2 3	07	27
BE10	Indian Springs, NV	2 3	11	9	05	3 2	12	14
BE22	Bishop, CA	6	02	4	05	1 1	05	37
BE32	Beatty, NV	5 2	16	6	05	5 9	16	6
BE37	Alamo, NV	2 9	06	1 7	08	4 6	10	14
BF03	Arcadia, UT	1 5	08	1 0	08	2 4	11	37
BF05	Altonah, UT	1 3	05	7	04	2 0	07	31
BF10	Duchesne, UT	1 0	06	5	05	1 5	08	32
BF13	Riverton, WY	2 1	06	1 5	06	3 7	08	20
BF15	Rawlins, WY	1 0	04	8	04	1 8	06	44
BF19	Upalco, UT	1 7	06	5	02	2 2	07	34
DZ01	Baker, NV	1 7	07	1 8	08	3 5	11	22
DZ04	Ely, NV	3 6	12	2 4	09	6 0	15	15
DZ05A	Ely, NV	3 9	15	1 1	06	5 0	16	17
DZ09A	McGill, NV	2 6	09	1	01	2 7	09	28
DZ10	Ibapah, UT	2 0	06	3	03	2 3	07	38
DZ16	Wendover, UT	1 9	08	8	04	2 6	09	28
DZ18	Tooele, UT	1 7	06	1 3	06	3 1	09	38
DZ21	Iosepa, UT	2 6	08	2 0	07	4 6	11	22
EML3	St George, UT	1 9	06	1 2	05	3 0	08	26
E20A	Kanab, UT	1 2	04	9	05	2 1	06	35
E26A	Parowan, UT	1 3	04	1 1	05	2 4	06	42
E35	Cedar City, UT	9	03	9	05	1 8	06	38
E132	Vernal, UT	1 1	04	9	05	2 0	07	34
FM01	Kingman, AZ	6	02	6	03	1 2	04	44
FM08	Grand Canyon, AZ	1 0	03	1 7	08	2 6	08	35
FM14	Tuba City, AZ	6	03	1 4	07	2 0	07	27
FM16	Gallup, NM	1 6	06	3	03	1 9	07	39
FM17	Holbrook, AZ	7	03	1 0	06	1 8	07	34
FM29	Ganado, AZ	2 5	08	5	04	3 0	09	20
FM31	Albuquerque, NM	2 7	09	8	04	3 5	10	17
FM32	Albuquerque, NM	4 3	15	1 1	06	5 3	17	12
FM33	Albuquerque, NM	3 4	10	8	06	4 2	11	20
FM33R	Albuquerque, NM	3 6	11	1 2	06	4 8	12	17
FM34	Albuquerque, NM	5 1	20	1 2	07	6 3	21	12
FM35	Albuquerque, NM	8 1	14	2 0	08	10 1	16	7
FM35R	Albuquerque, NM	8 4	29	1 8	09	10 2	30	7
FM39	Chinle, AZ	1 9	08	6	03	2 6	08	29
FM43	Williams, AZ	1 6	05	6	04	2 2	06	48
FM45	Flagstaff, AZ	1 0	04	8	04	1 8	06	45
FM46	Flagstaff, AZ	1 8	05	2	02	2 1	06	39
GC05	Reno, NV	6	04	5	04	1 1	05	42
GC06	Reno, NV	8	02	3	03	1 1	04	41

TABLE 2 COMPUTED $^{239+240}$Pu INVENTORIES(nCi/m^2) (continued)

Site	Location	Top		Bottom		Total		
		Pu	sd	Pu	sd	Pu	sd	Cs/Pu
GC08	Gerlach, NV	9	03	9	03	1 8	04	51
GC12	Lovelock, NV	8	03	3	03	1 1	04	45
GC15	Fallon, NV	7	03	8	05	1 5	06	43
GC19	Gabbs, NV	1 4	03	3	02	1 7	04	39
GC20	Austin, NV	1 4	08	5	04	1 9	09	42
GC23	Austin, NV	8	03	1 9	09	2 7	09	40
GC29	Bridgeport, CA	1 0	04	4	04	1 4	05	59
GC33	Hawthorne, NV	1 0	05	2	03	1 2	05	42
GC48	Stewart, NV	9	04	5	03	1 4	05	46
GC50	Moores Station, NV	1 6	04	1	02	1 8	05	32
KM06	Memphis, TN	1 8	06	5	04	2 3	07	53
KM13	Dallas, TX	1 2	04	2	02	1 4	05	49
KM18	Corpus Christi, TX	7	02	1	02	8	03	54
KM21	Corpus Christi, TX	7	03	2	03	1 0	04	47
KM28	Tucson, AZ	1 0	04	2	02	1 3	04	43
KM33	Tucson, AZ	7	03	4	03	1 1	04	41
KS01	Fredonia, AZ	1 3	07	8	05	2 1	09	38
KS07	Moccasin, AZ	2 0	06	7	04	2 7	08	24
KS10	Grand Canyon, AZ	3 3	09	5	03	3 8	09	35
KS21	Littlefield, AZ	2 1	07	2 3	09	4 3	11	28
KS24	Mesquite, NV	1 1	04	1 1	06	2 2	07	37
KS25	Bunkerville, NV	2 2	08	2 7	10	4 9	13	33
KS26	Bunkerville, NV	3 3	12	1 8	08	5 1	14	30
KS30	Overton, NV	1 3	04	7	04	2 0	05	32
KS33	Alamo, NV	2 3	12	1 3	06	3 6	14	12
KS36	Hiko, NV	1 9	08	1 4	07	3 3	10	19
MH02	Rosette, UT	2 6	07	2 0	10	4 6	12	37
MH03	Snowville, UT	2 3	08	6	04	2 9	09	45
MH07	Malad City, ID	1 7	09	9	08	2 6	12	35
MH12	Burley, ID	1 9	06	1	02	2 0	06	39
MH14	Twin Falls, ID	8	04	5	04	1 4	06	60
MH17	Twin Falls, ID	1 1	05	6	04	1 7	06	43
MH19	Meridian, ID	1 1	05	3	02	1 4	05	44
MH22	Boise, ID	1 5	07	4	03	1 9	08	40
MH28	Hines, OR	1 0	03	4	03	1 4	04	45
MH29	Basque Station, OR	1 0	04	6	03	1 6	05	50
NM02	Moriarty, NM	1 4	06	02	01	1 4	06	45
NM03	Belen, NM	9	04	4	03	1 3	05	35
NM04	Las Cruces, NM	6	03	2	02	7	03	38
NM05	Solomonville, AZ	6	03	1	01	7	03	59
NM06	Roswell, NM	9	04	4	03	1 3	05	43
NM07	Safford, AZ	5	02	4	03	9	04	49
NM08	Silver City, NM	8	03	6	05	1 4	06	43
NM09	Socorro, NM	8	03	7	04	1 5	05	31
NM11	Portales, NM	9	03	9	06	1 8	07	41
NM15	Sante Fe, NM	7	03	3	02	1 0	04	45
NM16	Sante Fe, NM	8	04	4	03	1 2	05	44
NM17	Raton, NM	1 4	05	6	03	2 0	06	40
NM18	Cimarron, NM	8	03	8	05	1 6	06	46
NM19	Chama, NM	1 4	05	3	02	1 7	05	49
NM21	Farmington, NM	9	04	3	02	1 3	04	37
NM22	Farmington, NM	8	03	5	03	1 3	05	44
NM25	Mesa, AZ	6	03	3	02	9	04	46
NM26	Litchfield Park, AZ	3	02	3	03	6	03	46
RB01	Scottsbluff, NE	1 2	05	8	04	1 9	06	48
RB08	Rapid City, SD	1 5	04	2 3	08	3 8	09	48
RB16	Billings, MT	1 4	05	5	04	1 9	06	50
RM02	Winnemucca, NV	1 2	04	5	03	1 6	05	42
RM06	Battle Mountain, NV	1 0	03	4	02	1 4	04	45
RM08	Carlin, NV	1 4	07	1	01	1 5	07	52
RM10	Elko, NV	9	04	7	07	1 6	08	46
RM12	Wells, NV	1 4	11	6	05	2 0	12	40
RM14	Pioche, NV	1 5	05	8	04	2 3	07	27
RM19	Panaca, NV	9	03	9	04	1 8	05	36
RM21	Caliente, NV	1 3	05	5	05	1 8	07	32
SA02	Wichita, KS	1 0	04	8	05	1 8	06	53
SA07	Wichita, KS	1 2	04	5	03	1 7	05	52
SA19	Des Moines, IA	1 3	04	8	04	2 1	05	54
SA20	St Louis, MO	1 3	04	6	04	1 9	05	55
SA26	St Louis, MO	1 5	04	1 0	04	2 5	06	49
SH07	Las Vegas, NV	1 2	04	8	03	2 0	05	20
SH10	Henderson, NV	7	03	1	02	9	04	38
SH11	Boulder City, NV	1 0	04	2	02	1 2	04	29
SW02	Lund, NV	1 5	06	1 2	05	2 7	08	27
SW03	Preston, NV	1 5	04	9	05	2 4	07	32
SW05	Eureka, NV	1 3	07	1	03	1 4	07	52
SW06	Duckwater, NV	4 0	11	1 0	06	5 0	13	14

ing process does not always extract all plutonium from the sample. The inefficiency of the leaching does not affect the computation of the amount of NTS fallout, but it can lead to underestimates of the total Pu inventory (Krey, 1983).

Table 2 also gives the ratio of the total Cs inventory to the total Pu inventory. The ratio of Cs to Pu in global fallout as of 1 January 1983 is known to be 48 ± 1% (H. Beck,

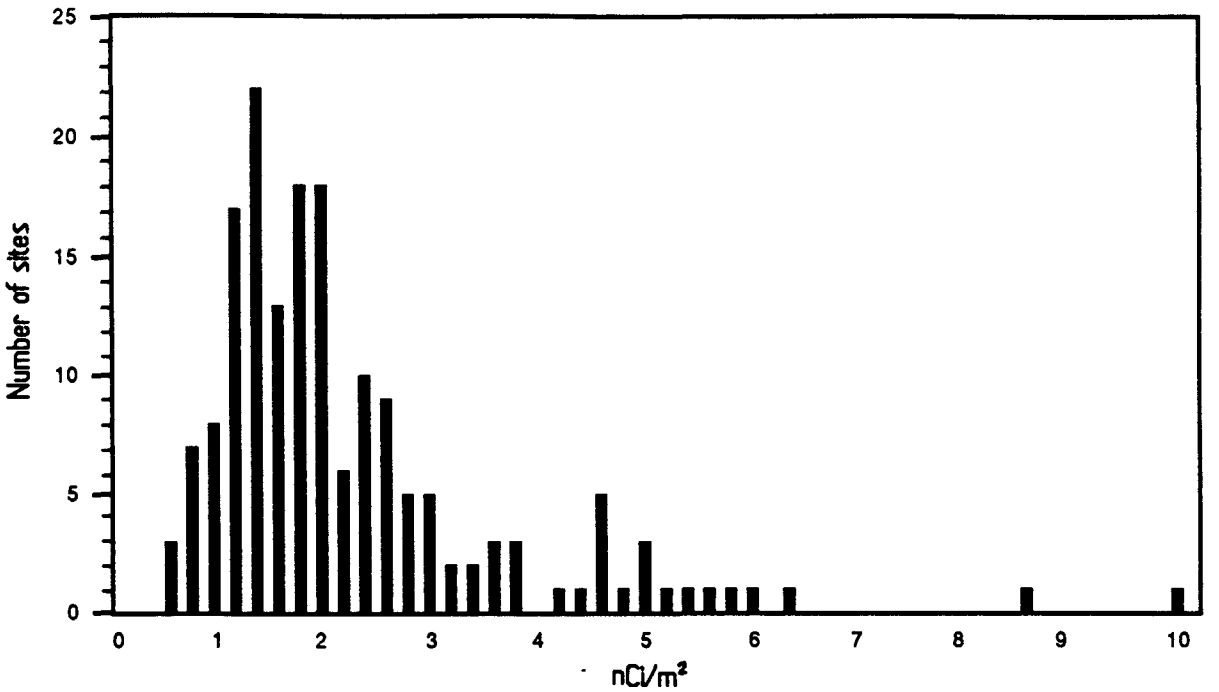

Figure 3. Histogram of total $^{239+240}Pu$ inventories.

personal communication) so examination of the inventory ratio gives an indication as to whether the fallout at a site is primarily global in nature.

The sources of variability that affect the Cs analyses also affect the Pu analyses. An additional source is the complicated chemistry required to separate the plutonium from the soil. An experiment carried out before the regular Pu analyses began showed a total analytical variability of 9 percent, with 5 percent due to counting error and 7 percent due to the chemical processing.

Another indication of the overall variability is given by the analysis of an EML reference soil from Massachusetts as part of the QA program. The data presented in Section 4 (Table 10) show the variability of the first counts of 25 aliquots of this soil (two counts were rejected by the QA criterion) to be 7.5 percent, while the individual counting errors ranged from 4.5 to 19 percent.

It must also be remembered that the correction factor used to adjust the early Pu results for incorrect aliquoting was based on the assumption that Cs and Pu have the

same distribution in the soil column. This assumption is an additional, if unmeasurable, source of uncertainty in the final results.

The Pu results from Albuquerque, New Mexico, require some further explanation. Initially, the samples from three Albuquerque sites (FM31, FM33, and FM35) were analyzed for Pu, and all three had Pu inventories well above the expected 1 to 1.5 nCi/m^2. Several steps were taken to investigate this anomaly, including analysis of new aliquots of the samples (FM33R and FM35R), analysis of 1982 samples from two other sites (FM32 and FM34), collection and analysis of new samples from all five sites (AQ05 through AQ09), and collection and analysis of samples from 28 new sites. Several soil samples collected in Albuquerque in the late 1950s were also analyzed, and historical records were examined thoroughly for any evidence that would help explain the results.

The investigation showed that

- several sites in central Albuquerque do have unusually high levels of Pu;
- the total Pu inventories at these sites are still quite low and do not constitute a health hazard;
- the excess Pu cannot be attributed to any NTS activities, nor to the test of the first atomic bomb at Alamogordo, New Mexico, in 1945, nor to any known accidental release of Pu.

These results were presented orally to the DAAG on 21 May 1987 (Beck, 1987). The DAAG agreed with the technical evaluation of the ORERP investigation and concluded that the levels of Pu in Albuquerque do not constitute a health hazard.

The sites with anomalous levels of Pu (FM31/AQ05, FM32/AQ06, FM33/AQ08, FM34/AQ09, FM35/AQ07, AQ04, AQ16, AQ24, AQ25, AQ28, AQ30, AQ31, and AQ33) will not be used in creating the County Database.

ISOTOPE RATIOS

The aliquots from all but 14 of the sites analyzed for Pu were submitted for isotope mass spectroscopy. Table 3 gives the ratios of ^{240}Pu to ^{239}Pu and ^{241}Pu to ^{239}Pu in the top and bottom increments. The values of these ratios in global fallout are 0.180 ± 0.006 and 0.00551 ± 0.00033, respectively, and deviations from these values again give a general idea of the size of the NTS fraction of the fallout at a site. More precise calculations of NTS fallout from these data will be reported by Anspaugh and Beck (1989).

TABLE 3. PLUTONIUM ISOTOPE RATIOS

Site	Location	$^{240}Pu/^{239}Pu$ Top Ratio	sd	$^{240}Pu/^{239}Pu$ Bottom Ratio	sd	$^{241}Pu/^{239}Pu$ Top Ratio	sd	$^{241}Pu/^{239}Pu$ Bottom Ratio	sd
AF01	Talmage, UT	1173	00004	1199	00010	00303	00001	00307	00001
AF05	Talmage, UT	1274	00005	1282	00100	00324	00001	00318	00004
AF14	Mountain Home, UT	1446	00010	1410	00010	00369	00001	00348	00001
AQ01	Albuquerque, NM	1671	00020	1640	00060	00347	00001	00343	00009
AQ04	Albuquerque, NM	0684	00020	0893	00010	00133	00003	00167	00001
AQ06	Albuquerque, NM	0619	00006	0902	00020	00115	00001	00160	00010
AQ07	Albuquerque, NM	0400	00004	0609	00010	00063	00000	00103	00000
AQ09	Albuquerque, NM	0470	00030	0715	00020	00083	00002	00122	00001
AQ11	Albuquerque, NM	1563	00010	1431	00010	00318	00001	00283	00001
AQ12	Albuquerque, NM	1466	00010	1403	00010	00312	00001	00283	00002
AQ13	Albuquerque, NM	1564	00020	1320	00030	00317	00001	00265	00002
AQ14	Albuquerque, NM	1528	00010	1399	00020	00318	00001	00276	00001
AQ15	Albuquerque, NM	1568	00040	1511	00010	00331	00003	00304	00001
AQ16	Albuquerque, NM	0174	00001	0165	00003	00018	00000	00015	00001
AQ17	Albuquerque, NM	1509	00030	1401	00030	00314	00001	00297	00003
AQ18	Albuquerque, NM	1621	00020	1330	00040	00346	00001	00249	00002
AQ19	Albuquerque, NM	1649	00030	1319	00020	00355	00001	00261	00001
AQ20	Albuquerque, NM	1510	00020	1522	00070	00310	00001	00306	00003
AQ21	Albuquerque, NM	1513	00030	1364	00020	00313	00002	00274	00001
AQ23	Albuquerque, NM	1525	00010	1110	00030	00314	00001	00217	00005
AQ24	Albuquerque, NM	1131	00020	1399	00020	00230	00002	00271	00001
AQ25	Albuquerque, NM	0426	00003	1681	00010	00070	00000	00358	00001
AQ27	Albuquerque, NM	1586	00020	1278	00010	00323	00001	00253	00002
AQ28	Albuquerque, NM	0461	00004	1572	00030	00079	00000	00308	00003
AQ29	Albuquerque, NM	1587	00020	1565	00020	00323	00001	00318	00002
AQ31	Albuquerque, NM	1539	00020	1005	00030	00316	00002	00195	00001
AQ32	Albuquerque, NM	1382	00040	1473	00020	00284	00002	00292	00001
AQ33	Albuquerque, NM	0478	00010	0899	00020	00084	00000	00158	00001
AS06	Cortez, CO	0914	00010	1247	00020	00196	00001	00266	00002
AS10	Durango, CO	1566	00120	1538	00020	00358	00010	00333	00002
AS13	Silverton, CO	1633	00020	1612	00040	00369	00001	00357	00003
AS21	Fruita, CO	1280	00010	1250	00010	00285	00001	00275	00001
AS26	Meeker, CO	1333	00010	1184	00020	00297	00001	00253	00003
AS27	Craig, CO	1443	00020	1453	00040	00326	00001	00333	00002
AS32	Rock Springs, WY	1160	00010	1036	00010	00272	00001	00228	00001
AS36	Kemmerer, WY	1547	00050	1498	00040	00350	00005	00334	00004
AS41	Afton, WY	1530	00010	1492	00020	00345	00001	00328	00001
AS43	Idaho Falls, ID	1671	00010	1656	00020	00407	00001	00399	00002
AS50	Pocatello, ID	1725	00010	1671	00010	00424	00001	00392	00001
BA03	Seattle, WA	1815	00020	1458	00010	00422	00001	00328	00001
BA11	Medford, OR	1710	00010	1702	00020	00385	00001	00377	00003
BA15	San Francisco, CA	1678	00010	1584	00050	00368	00002	00339	00004
BA29	Los Angeles, CA	1402	00030	1481	00030	00325	00002	00344	00004
BA30	Los Angeles, CA	1419	00020	1381	00050	00311	00002	00299	00008
BE01	Furnace Creek, CA	1114	00030	0787	00010	00245	00001	00165	00001
BE10	Indian Springs, NV	0566	00010	0638	00010	00112	00002	00126	00001
BE22	Bishop, CA	1440	00030	1353	00030	00329	00002	00308	00005
BE32	Beatty, NV	0378	00010	0960	00020	00072	00002	00209	00003
BE37	Alamo, NV	0638	00010	0647	00020	00120	00001	00116	00001
BF03	Arcadia, UT	1322	00010	1339	00020	00334	00001	00328	00002
BF05	Altonah, UT	1225	00010	1240	00010	00302	00001	00305	00001
BF10	Duchesne, UT	1318	00005	1102	00010	00324	00001	00254	00001
BF13	Riverton, WY	0703	00010	0648	00020	00138	00001	00122	00001
BF15	Rawlins, WY	1406	00010	1344	00020	00321	00001	00303	00002
BF19	Upalco, UT	1312	00005	1221	00010	00328	00001	00290	00001
DZ01	Baker, NV	1085	00010	0822	00010	00250	00001	00174	00001
DZ04	Ely, NV	0870	00040	0641	00020	00180	00004	00127	00003
DZ05A	Ely, NV	0742	00010	1193	00010	00161	00001	00281	00001
DZ09A	McGill, NV	1151	00010	1373	00040	00271	00001	00360	00004
DZ10	Ibapah, UT	1350	00010	1432	00020	00303	00001	00332	00002
DZ16	Wendover, UT	1519	00010	1519	00010	00369	00001	00365	00001
DZ18	Tooele, UT	1433	00010	1313	00010	00341	00001	00298	00001
DZ21	Iosepa, UT	0877	00010	0836	00010	00192	00001	00169	00001
EML3	St George, UT	0787	00010	0709	00010	00157	00001	00132	00001
E20A	Kanab, UT	1232	00010	1141	00010	00279	00001	00243	00001
E26A	Parowan, UT	1438	00010	1366	00020	00324	00001	00297	00002
E35	Cedar City, UT	1420	00010	1206	00020	00310	00001	00266	00001
E132	Vernal, UT	1220	00010	1176	00030	00273	00001	00288	00004
FM01	Kingman, AZ	1606	00010	1116	00030	00372	00001	00212	00002
FM08	Grand Canyon, AZ	1113	00010	1144	00010	00246	00001	00237	00001
FM14	Tuba City, AZ	1579	00020	0910	00010	00369	00001	00185	00001
FM16	Gallup, NM	1248	00040	1390	00010	00272	00001	00288	00002
FM17	Holbrook, AZ	1580	00010	1202	00010	00363	00001	00257	00001
FM29	Ganado, AZ	0990	00010	1230	00020	00210	00001	00260	00001
FM31	Albuquerque, NM	0571	00030	0878	00010	00108	00002	00169	00002
FM33	Albuquerque, NM	0606	00060	0910	00060	00130	00008	00178	00006
FM35	Albuquerque, NM	0382	00010	0505	00010	00065	00001	00088	00001
FM39	Chinle, AZ	1245	00010	1183	00030	00264	00001	00243	00002
FM43	Williams, AZ	1603	00020	1415	00050	00347	00002	00305	00006
FM45	Flagstaff, AZ	1585	00020	1534	00020	00362	00002	00332	00002
FM46	Flagstaff, AZ	1602	00010	1392	00070	00350	00001	00324	00007
GC05	Reno, NV	1666	00020	1576	00040	00380	00003	00368	00010
GC06	Reno, NV	1617	00030	1485	00140	00366	00005	00396	00019
GC08	Gerlach, NV	1712	00020	1657	00020	00381	00003	00353	00002
GC12	Lovelock, NV	1756	00010	1546	00010	00413	00001	00347	00002
GC15	Fallon, NV	1597	00010	1627	00020	00372	00001	00368	00003
GC19	Gabbs, NV	1575	00070	1495	00040	00352	00004	00308	00002
GC20	Austin, NV	1674	00010	1559	00040	00424	00001	00363	00008
GC23	Austin, NV	1523	00230	1396	00020	00368	00009	00306	00001
GC33	Hawthorne, NV	1695	00010	1454	00020	00408	00001	00359	00002
GC48	Stewart, NV	1730	00020	1738	00030	00396	00002	00386	00003
GC50	Moores Station, NV	1105	00010	1110	00040	00245	00001	00258	00007
KM06	Memphis, TN	1753	00020	1733	00050	00394	00001	00376	00003
KM13	Dallas, TX	1704	00020	1721	00030	00388	00003	00391	00004
KM21	Corpus Christi, TX	1711	00040	1697	00020	00376	00005	00370	00003
KM28	Tucson, AZ	1722	00030	1581	00050	00386	00003	00358	00004

TABLE 3. PLUTONIUM ISOTOPE RATIOS (continued)

Site	Location	$^{240}Pu/^{239}Pu$ Top Ratio	Top sd	Bottom Ratio	Bottom sd	$^{241}Pu/^{239}Pu$ Top Ratio	Top sd	Bottom Ratio	Bottom sd
KM33	Tucson, AZ	1647	00030	1577	00070	00383	00004	00362	00006
KS01	Fredonia, AZ	1368	00010	1144	00010	00324	00001	00227	00001
KS07	Moccasin, AZ	1014	00010	0999	00020	00214	00001	00192	00002
KS10	Grand Canyon, AZ	1257	00040	1388	00020	00260	00003	00299	00002
KS21	Littlefield, AZ	1152	00010	1064	00010	00245	00001	00213	00001
KS24	Mesquite, NV	1212	00010	0994	00010	00276	00001	00197	00001
KS25	Bunkerville, NV	1120	00010	0977	00010	00243	00001	00200	00001
KS26	Bunkerville, NV	1077	00010	0834	00010	00237	00001	00164	00001
KS30	Overton, NV	1072	00020	0950	00020	00226	00001	00194	00003
KS33	Alamo, NV	0615	00010	0636	00020	00134	00001	00133	00002
KS36	Hiko, NV	0749	00040	0749	00010	00156	00005	00142	00002
MH02	Rosette, UT	1593	00050	1409	00020	00368	00001	00306	00001
MH03	Snowville, UT	1555	00010	1615	00020	00348	00005	00364	00002
MH07	Malad City, ID	1606	00010	1629	00020	00391	00001	00392	00002
MH12	Burley, ID	1460	00010	1447	00020	00346	00001	00347	00001
MH14	Twin Falls, ID	1603	00030	1644	00010	00359	00002	00370	00001
MH17	Twin Falls, ID	1680	00020	1443	00020	00383	00002	00309	00002
MH19	Meridian, ID	1754	00020	1677	00030	00396	00003	00374	00001
MH22	Boise, ID	1761	00010	1563	00020	00427	00001	00334	00003
MH28	Hines, OR	1714	00020	1686	00030	00381	00002	00355	00003
MH29	Basque Station, OR	1736	00020	1738	00020	00402	00002	00397	00001
NM02	Moriarty, NM	1540	00010	1295	00070	00305	00001	00307	00008
NM03	Belen, NM	1670	00020	1241	00010	00350	00001	00235	00001
NM04	Las Cruces, NM	1681	00010	1573	00040	00343	00001	00315	00003
NM05	Solomonville, AZ	1627	00050	1460	00030	00326	00003	00290	00003
NM06	Roswell, NM	1656	00020	1355	00010	00342	00001	00262	00002
NM07	Safford, AZ	1691	00020	1645	00020	00347	00001	00320	00002
NM08	Silver City, NM	1661	00020	1626	00030	00339	00001	00323	00003
NM09	Socorro, NM	1314	00010	1168	00010	00259	00001	00218	00001
NM11	Portales, NM	1689	00010	1479	00020	00361	00001	00293	00003
NM15	Sante Fe, NM	1759	00010	1473	00010	00384	00001	00285	00003
NM16	Sante Fe, NM	1637	00010	1476	00030	00340	00001	00297	00003
NM17	Raton, NM	1412	00010	1491	00030	00286	00001	00270	00001
NM18	Cimarron, NM	1621	00010	1603	00020	00332	00001	00322	00001
NM19	Chama, NM	1704	00020	1633	00020	00342	00001	00325	00001
NM21	Farmington, NM	1479	00010	1245	00070	00296	00001	00226	00004
NM22	Farmington, NM	1604	00020	1552	00020	00321	00001	00307	00002
NM25	Mesa, AZ	1649	00010	1641	00080	00337	00001	00322	00005
NM26	Litchfield Park, AZ	1610	00010	1552	00020	00330	00001	00316	00003
RB01	Scottsbluff, NE	1586	00030	1585	00040	00359	00002	00352	00002
RB08	Rapid City, SD	1740	00020	1716	00020	00422	00003	00395	00003
RB16	Billings, MT	1734	00010	1665	00130	00409	00002	01140	00050
RM02	Winnemucca, NV	1563	00020	1607	00030	00353	00001	00351	00004
RM06	Battle Mountain, NV	1464	00010	1335	00030	00330	00001	00289	00003
RM08	Carlin, NV	1641	00040	1553	00040	00368	00003	00349	00003
RM10	Elko, NV	1650	00010	1642	00020	00402	00001	00391	00002
RM12	Wells, NV	1504	00010	1514	00010	00369	00001	00354	00002
RM14	Pioche, NV	1172	00020	0862	00030	00256	00002	00164	00003
RM19	Panaca, NV	1126	00010	1181	00010	00258	00001	00261	00001
RM21	Caliente, NV	1143	00010	1095	00020	00252	00001	00243	00001
SA07	Wichita, KS	1711	00010	1644	00040	00388	00002	00364	00004
SA19	Des Moines, IA	1793	00030	1748	00040	00406	00002	00402	00004
SA20	St Louis, MO	1830	00020	1706	00020	00414	00001	00365	00002
SA26	St Louis, MO	1816	00010	1805	00030	00416	00002	00402	00002
SH07	Las Vegas, NV	0884	00020	0892	00010	00183	00001	00184	00001
SH10	Henderson, NV	1188	00040	1071	00040	00272	00001	00224	00006
SH11	Boulder City, NV	1180	00020	1134	00020	00257	00002	00260	00002
SW02	Lund, NV	1025	00010	0920	00010	00224	00001	00189	00001
SW03	Preston, NV	1103	00020	0994	00040	00240	00002	00205	00004
SW05	Eureka, NV	1840	00010	1516	00040	00494	00001	00357	00004
SW06	Duckwater, NV	0711	00020	1064	00020	00141	00002	00225	00001

Table 3 shows the reported standard deviations of the measured isotope ratios to be small, almost always less than one percent. The 27 analyses of an IMS standard for the QA program had a standard deviation of 0.4 percent, but these standards did not undergo the chemistry used to prepare the regular samples. The overall variability of the IMS results will therefore be somewhat larger than the reported values, but the IMS errors are still insignificant in comparison to the uncertainty of the estimated inventories.

SECTION 4
QUALITY OF THE DATA

INTRODUCTION

The aim of the ORERP soils program was to produce accurate and reliable results comparable to those produced by EML in Utah in 1979. Originally it was hoped that EML would do an expanded study itself, but that laboratory was unable to take on so large a project. Instead, the work was assigned to DOE contractors, but the EML scientists who did the Utah study agreed to advise the ORERP leaders and help ensure that the work was consistent with the established EML procedures.

An important function of EML was to help set up and coordinate a QA program. Many elements of the QA program, such as the evaluation of potential sites by different groups and the removal of identifying information from samples before processing began, were noted in Section 2. This section focuses on the more quantitative QA aspects of the laboratory analyses of the soil samples. It includes a description of several experiments conducted by EML to pre-qualify the REECo laboratories to do the preparation and analysis and to monitor the quality of the results; a detailed discussion of the QA criteria applied to the analytical results; and a summary of the quality of the final data set used in developing the County Database.

EML SUPERVISION OF THE SOIL ANALYSES

Pre-qualification

To ensure that the REECo Analytical Laboratory could analyze the ORERP samples with sufficient accuracy and precision, EML sent two sets of soil samples to REECo for analysis in mid-1982. The cesium results showed a slight bias that was further investigated as described in "Duplicate Gamma Counts" below. The plutonium results were acceptable except for one sample, which was 10 times as high as it should have been. This apparent contamination led to a thorough evaluation of the REECo laboratory procedures.

Another set of samples analyzed for plutonium in October 1982 showed no evidence of contamination or bias in the results, but the variability of replicate analyses was an unac-

ceptable 24 percent. REECo continued to refine its procedures, and by June 1983 was able to reduce the variability to less than 10 percent. At that time, EML gave approval for REECo to begin plutonium analysis of the ORERP samples.

Analysis of Coarse Material

The method of soil preparation used at REECo differs from that used at EML, where the standard procedure is to crush and pulverize the soil into a homogeneous sample. REECo's ball-milling procedure has the advantages of minimizing the possibility of cross-contamination (because the grinding is done in a closed container) and simplifying clean-up. It has an obvious disadvantage in that it leaves a residue of coarse material that is not normally analyzed for radioactivity. An important question at the start of the program was whether ball-milling would give accurate results.

In June 1982, REECo collected composite samples of 10 top-increment cores from 25 sites for a ball-milling experiment. These samples were ball-milled as usual, then the coarse fractions were pulverized and analyzed separately. Only one of the 25 coarse fractions had detectable cesium, and that one had only 0.4 percent of the total activity in the sample. The one coarse fraction analyzed for plutonium had no detectable activity.

Another part of the EML-REECo comparison was the sampling of 13 sites by both REECo and EML in 1982. (In most cases the REECo sampling team did not know which sites EML would also sample.) To try to resolve some discrepancies between the EML and REECo results at two of these sites, the coarse material from five samples was gamma-counted (without being pulverized) in July 1985. One sample showed no cesium activity, but the other four all had about one-tenth as much activity as the corresponding fine fractions. While these results conflict with the earlier analyses, the size of the coarse fraction at these two sites was relatively large. Since the amount of coarse material at most sites was small, the scientific staff concluded that not analyzing the coarse fraction had a negligible effect at almost all sites. The error involved at the two sites in question above was also considered insignificant.

Duplicate Gamma Counts

To further compare the gamma-spectrometry results at the two laboratories, 13 ORERP aliquots were sent to EML for analysis in 1983. The results showed a density-dependent bias in the REECo measurements, with overestimates at low soil densities and underestimates at high densities. The analysis at EML of 10 more duplicate aliquots in March 1984 further demonstrated this bias. Correction factors were therefore derived to

calibrate REECo's results, using the EML analysis of the 23 duplicate aliquots as a secondary standard.

In January 1985, EML found that REECo's results from 1,000-minute recounts were consistently larger than the results from the original 300-minute counts. This second source of bias, which affected only low-activity results, was found to be related to the algorithm used by REECo to analyze the spectra. At this point, the decision was made to reanalyze all the gamma-ray spectra at EML using a new peak-stripping algorithm to get revised total-absorption peak count rates for the various radionuclides of interest. The calibration (*i.e.*, conversion from count rate to activity) was based on the independent EML counts of the set of 23 samples covering the entire range of sample densities. EML's calibration is traceable to the National Bureau of Standards and has an accuracy better than five percent. Background corrections were based on weekly REECo background counts.

The reanalysis of the spectra was completed in May 1985. All subsequent gamma-ray spectra were also analyzed at EML, and all the gamma-spectrometry results reported here are EML results. In most cases the difference between the REECo and EML results was minimal.

Duplicate Sites

In addition to the collection of soil samples by both REECo and EML at 13 ORERP sites, REECo collected samples at five sites in Utah sampled by EML in 1979. The Cs and Pu inventories computed from the REECo and EML samples did not agree initially, and investigation of the discrepancies revealed the two problems noted in Section 3: That augers of different sizes were used to collect the fourth-increment samples, and that the plutonium aliquots had been incorrectly prepared.

Resolving these problems eliminated most of the discrepancies in the ORERP-EML comparisons. The averages of the corrected ratios of the inventories computed by ORERP to those computed by EML were close to 1.0: 0.95 ± 0.02 for Cs (based on 16 sites) and 0.98 ± 0.02 for Pu (15 sites). The average ORERP/EML ratio of the $^{240}Pu/^{239}Pu$ values for 15 sites was 0.99 ± 0.01.

QA CRITERIA

Each stage of the analytical process had a set of QA criteria to be applied to the results. These criteria were spelled out in Appendix F of Project Directive No. 4, and that document forms the cornerstone for the discussion that follows. Project Directive No. 4 is

included in this report as Appendix A; to avoid confusion, Appendix F (which is contained in Appendix A) will be referred to here as the "QA plan."

Although QA samples were included with every batch of samples sent to the laboratory for analysis, the QA plan was not formally written up until February 1984, well after the program had begun. In addition, some of the procedures specified in the plan were later modified. The differences between the details of the QA plan and the way the QA program was actually carried out are documented here to facilitate an objective analysis of the quality of the data.

For convenience, the various QA criteria are numbered in the discussion that follows although they are not numbered in the original plan. All sample statistics (means and standard deviations) used in the calculation of QA limits were computed from the 1982–1985 results. The same criteria were applied to the 1986–1987 results, but the statistics were not recomputed.

Gamma Analyses

The most important QA element of both the gamma and plutonium analyses was the analysis of samples of reference soils. Interspersing the reference samples with the regular samples as they were submitted for analysis provided checks on the consistency of the analytical results.

Of the 1,039 bottles submitted for gamma-counting, 96 (9%) contained one of two reference soils. One reference soil was collected on 28 December 1982 at site EML16 in Hurricane, Utah. Forty-four cores of the top 6 inches of soil were collected, dried, and homogenized as one large batch, and numerous aliquots were then prepared for gamma and plutonium analysis. Blank soil was collected by EML from several feet underground in a pit at Chester, New Jersey, and shipped to DRI in plastic bags, which were numbered and inserted separately into the sample stream at irregular intervals. Previous analysis of this soil by EML showed it to have no detectable Cs within the sensitivity limits of the ORERP analyses.

The QA plan is written as if there were a continuous stream of samples flowing through the soil preparation/gamma-counting process, and this is reasonably accurate. However, the QA referee had no control over the order of samples in the stream, and thus had no way of ensuring that QA samples were inserted randomly. The QA samples were added periodically throughout the process, and it seems likely that most of them ended up in

somewhat random positions in the stream. However, there was at least one instance where seven QA samples were apparently counted one after another.

All of the data reported here are from the EML analysis of the gamma-ray spectra, even though any QA decisions made before May 1985 would have been based on the original (unreported) REECo analyses. The differences between the REECo and EML analyses were usually minimal and would not have affected most of the QA decisions.

Blank Soil

Table 4 gives the results of the gamma analyses of blank soil. The first four sample numbers were given to four bags that were submitted as a complete dummy site to test for contamination in the preparation laboratory. The other samples analyzed in 1983 and 1984 were submitted separately in bags of roughly the same size as an ordinary upper-increment sample. The seven blank samples counted in 1986 and 1987 were previously-prepared bot-

TABLE 4. GAMMA-SPECTROMETRY RESULTS FOR BLANK SOIL

ID	Date	Concentration (pCi/g) and s.d. (%)							
		^{137}Cs		^{238}U		^{232}Th		^{40}K	
72010	04-09-83	.003	326.6	.29	7.6	.22	13.2	25.3	1.5
72010*	05-14-83	.004	125.5	.29	4.2	.15	10.0	25.0	.8
72019	04-09-83	.004	238.8	.28	8.2	.12	24.5	28.8	1.4
72019*	05-27-83	.003	193.8	.31	4.0	.19	8.2	28.6	.8
72021	04-09-83	.007	120.2	.27	8.3	.17	16.9	27.6	1.4
72021*	05-21-83	.000	999.9	.33	3.8	.17	9.3	27.3	.8
72022	04-09-83	.001	992.4	.34	7.0	.19	15.9	24.8	1.5
72022*	05-22-83	.010	58.2	.35	3.7	.19	8.7	25.1	.8
72143	05-04-83	.006	149.2	.44	5.6	.18	16.2	27.2	1.5
72143*	06-02-83	-.004	-141.5	.31	4.0	.17	9.1	27.7	.8
72143*	02-07-84	.005	111.1	.31	4.1	.19	8.2	28.1	.8
72169	06-14-83	.013	68.1	.33	7.1	.21	14.4	26.1	1.5
72202	06-18-83	.014	65.5	.29	8.1	.20	14.6	28.0	1.5
72227	07-16-83	.008	106.1	.30	7.6	.15	18.6	25.9	1.5
72245	07-27-83	-.010	-87.8	.26	8.4	.14	21.0	26.4	1.5
72245*	10-09-83	-.001	-471.2	.30	4.1	.14	10.6	25.9	.8
72287	08-06-83	.008	116.0	.29	7.9	.19	15.6	28.5	1.4
72369	10-16-83	-.001	-1402.4	.30	7.4	.16	16.8	21.7	1.7
72451	11-27-83	.003	282.8	.33	6.9	.12	23.7	25.5	1.5
72604	04-03-84	.015	58.5	.26	8.2	.13	20.3	22.3	1.6
72616	04-07-84	.013	66.1	.29	7.9	.15	19.8	26.2	1.5
72624	03-24-84	-.011	-76.3	.31	7.3	.12	23.5	24.5	1.6
72684	05-17-84	.005	178.1	.30	7.2	.17	16.4	23.7	1.5
72685	05-17-84	.016	52.9	.29	7.7	.19	15.5	26.6	1.5
73050	06-27-84	.003	340.0	.31	7.5	.14	20.8	25.1	1.5
73051	06-12-84	.003	322.2	.31	7.4	.16	17.9	26.6	1.5
73067	08-11-84	-.001	-608.1	.26	8.4	.18	15.8	26.8	1.5
73070	08-13-84	-.006	-146.1	.30	7.5	.14	20.0	26.6	1.5
73128	11-28-86	.003	309.1	.34	6.9	.14	20.7	26.5	1.5
73230	02-01-87	-.002	394.0	.36	6.6	.14	20.5	25.7	1.5
73632	05-23-87	.009	109.2	.35	6.7	.15	19.7	26.4	1.5
73658	05-29-87	.014	67.8	.34	6.7	.19	14.9	25.9	1.5
73668	06-02-87	.011	84.5	.35	6.9	.19	15.8	28.6	1.4
73701	06-11-87	.003	279.3	.29	7.6	.16	17.7	23.9	1.5
73704	06-13-87	.010	91.9	.34	6.8	.17	17.0	27.7	1.4

* = 1,000-minute count

tles that were recounted. Those samples do not check for contamination in the preparation process, and the data from them are not used in the following analysis.

The results are judged by two criteria: The Cs activity should be close to zero, and the activities of the natural radionuclides should be about the same from one sample to another.

Criterion 1: Recount a blank sample if its Cs content is greater than 2.33 times the counting uncertainty.

Criterion 1 and several similar criteria are based on the assumption that the estimated values have a normal distribution with a certain mean and standard deviation. In the present case it is assumed that the estimates of Cs in the blank soil are normally distributed about a mean of zero, and if this assumption is true, only 1% of the estimates (on the average) will exceed 2.33 times the standard deviation. Because very few "good" estimates will exceed the 2.33 x s.d. criterion, any estimates that do exceed it are assumed to indicate a problem with the analytical process.

The counting uncertainty is a function of the Cs level, so Criterion 1 is equivalent to a test on the counting error:

Recount if Cs > 2.33 x counting uncertainty

Cs > 2.33 x Cs x %sd/100

or 42.9 > %sd.

All reported Cs activities had standard deviations of more than 42.9 percent, so all the blank samples satisfy this criterion. (A standard deviation cannot be less than zero, and the negative values reported by EML are treated here as positive.)

Criterion 2: Recount samples if the activity of one of the natural radionuclides in a blank sample differs from its mean by more than 2.39 times the standard deviation of the difference.

The QA plan was based on the REECo analysis of the gamma spectra, which included ^{226}Ra, ^{228}Ra, and ^{228}Th among the natural radionuclides reported. The EML analysis of the same spectra reported ^{232}Th and ^{238}U instead.

If each radionuclide is normally distributed about its mean, each difference is also normally distributed about a mean of zero. The probability that any one of the three differences will be within 2.39 standard deviations of zero is 0.9832, and if the differences are statistically independent, the probability that all three are within 2.39 standard deviations of

zero is $(0.9832)^3 = 0.9504$. Thus there is about a 5% chance of incorrectly ordering a recount based on Criterion 2.

Six blank samples were counted more than once. Variance-weighted averages of the multiple results for each radionuclide in those samples were used in the subsequent calculations.

The standard deviation of the difference between the activity in a sample and its mean is computed as follows. Let

X = radionuclide activity in a sample
$\overline{X}$ = average value of X in n samples
$s(X)$ = standard deviation of X in n samples
D = difference = $X - \overline{X}$

Statistical theory gives the formula for s(D) as

$$\begin{aligned} s(D) &= [\text{Variance}(D)]^{1/2} \\ &= [s(X)^2 - s(\overline{X})^2]^{1/2} \\ &= [s(X) \times (n-1)/n]^{1/2} \end{aligned}$$

Any values of X that differ from $\overline{X}$ by more than 2.39s(D) are considered suspect.

Results (in pCi/g) computed from the data in Table 4 are shown below:

	^{238}U	^{232}Th	^{40}K
$\overline{X}$	0.302	0.163	25.90
s(X)	0.022	0.026	1.82
$\overline{X} - 2.39s(D)$	0.251	0.103	21.66
$\overline{X} + 2.39s(D)$	0.353	0.223	30.14

The data and their control limits are plotted in Figure 4. All estimates of all three natural radionuclides fall within the indicated limits.

Hurricane Soil

Results for the analyses of Hurricane soil are shown in Table 5. Because all of these samples came from the same homogeneous batch of soil, the results should be similar from one analysis to another.

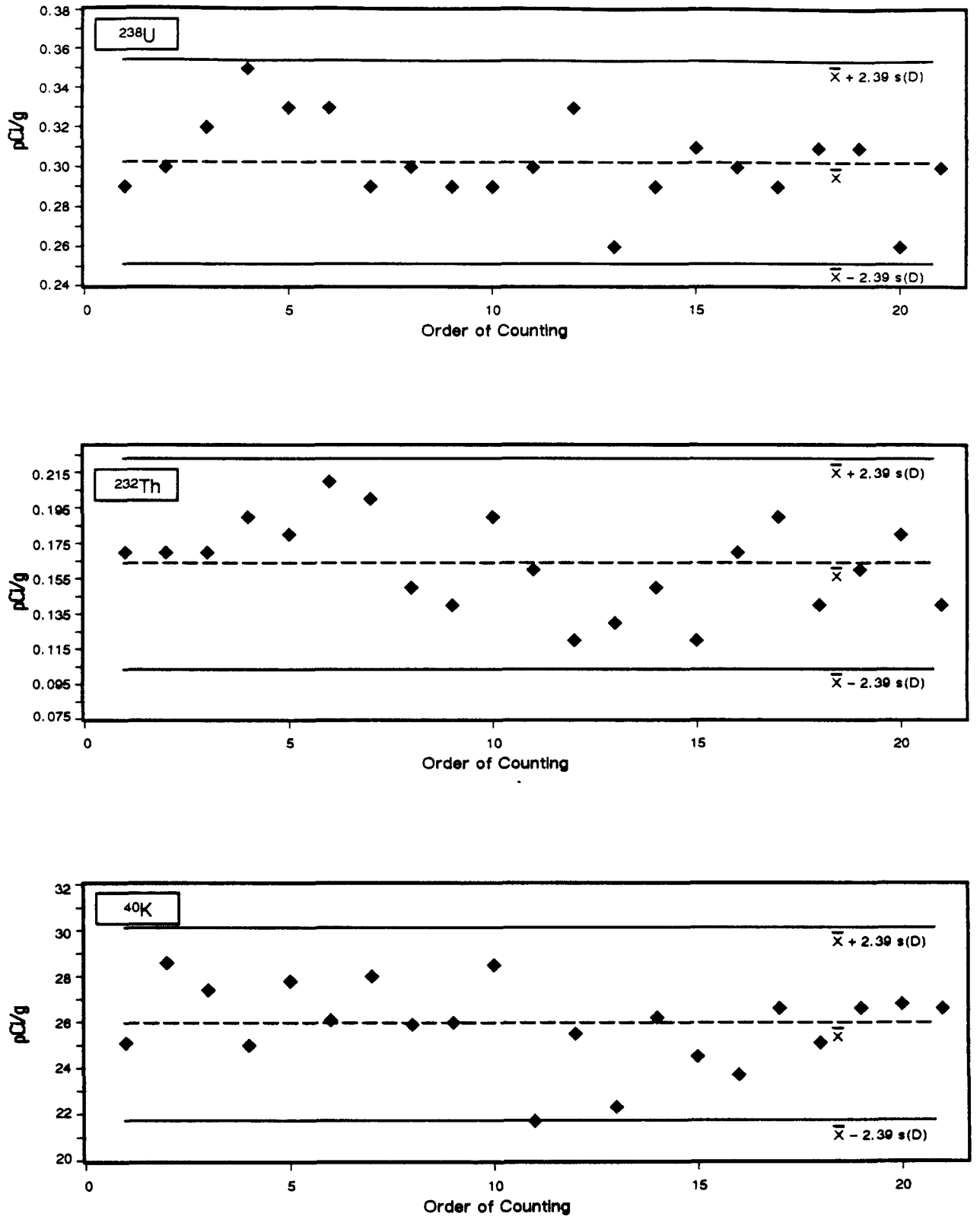

Figure 4. Measurements of natural radionuclides in blank soil.

TABLE 5. GAMMA-SPECTROMETRY RESULTS FOR HURRICANE SOIL

ID	Date	Concentration (pCi/g) and s.d. (%)							
		^{137}Cs		^{238}U		^{232}Th		^{40}K	
72126	02-17-83	.532	3.2	.86	3.6	.86	4.9	15.4	2.0
	02-28-83	.541	3.1	.87	3.6	.83	5.0	15.9	2.0
72183	04-13-83	.498	3.3	.88	3.5	.97	4.4	16.0	1.9
72184	04-14-83	.502	3.3	.88	3.6	.81	5.1	15.5	2.0
72185	05-01-83	.516	3.2	.81	3.7	.80	5.1	15.5	1.9
72186	05-02-83	.511	3.2	.90	3.5	.88	4.9	15.2	2.0
72213	06-12-83	.536	3.1	*.79	3.8	.85	4.9	15.6	1.9
72214	06-12-83	.519	3.2	.88	3.6	.83	5.1	16.1	1.9
72240	06-20-83	.524	3.1	.82	3.7	.93	4.6	16.0	1.9
72241	06-20-83	.544	3.1	.91	3.4	.90	4.7	15.2	2.0
72242	06-20-83	.509	3.3	.85	3.6	.87	4.9	15.4	2.0
72293	06-28-83	.563	3.0	.85	3.7	.88	4.8	15.6	2.0
72294	06-29-83	.559	3.1	.91	3.6	.87	4.9	16.0	2.0
72295	07-31-83	.543	3.1	.84	3.7	.84	5.1	16.0	1.9
72296	07-31-83	.571	3.0	.88	3.6	.86	5.0	16.2	1.9
72297	07-31-83	.588	3.0	.91	3.5	.87	4.9	15.8	1.9
72298	07-31-83	.545	3.1	.83	3.6	.86	4.9	15.0	2.0
72347	08-06-83	.536	3.1	.86	3.6	.86	4.9	15.4	2.0
	08-29-83	.515	3.2	.88	3.6	.96	4.5	15.6	1.9
72348	08-11-83	.526	3.2	.90	3.5	.86	4.9	16.1	1.9
72349	08-24-83	.513	3.2	.85	3.6	.86	4.9	16.5	1.9
72350	08-24-83	.514	3.2	.90	3.5	.90	4.7	15.6	1.9
72351	09-05-83	.532	3.1	.85	3.7	.90	4.7	15.5	2.0
72352	09-05-83	.529	3.2	.90	3.5	.88	4.8	16.5	1.9
72420	09-14-83	.562	3.0	.88	3.5	.88	4.7	15.9	1.9
72421	09-14-83	.504	3.3	.91	3.5	*.98	4.4	16.3	1.9
72428	09-20-83	.509	3.2	.85	3.6	.83	5.0	16.0	1.9
72429	09-25-83	.554	3.1	.93	3.4	.88	4.9	15.6	2.0
72430	09-23-83	.558	3.1	.88	3.5	.93	4.6	16.1	1.9
72431	09-23-83	.530	3.1	.90	3.4	.89	4.8	15.5	2.0
72432	09-24-83	.503	3.3	.90	3.4	.90	4.7	15.8	1.9
72433	09-24-83	.536	3.1	.81	3.7	.85	4.9	15.9	1.9
72434	09-24-83	.554	3.1	.88	3.6	.78	5.3	15.8	2.0
72435	09-24-83	.520	3.2	.88	3.5	.86	4.9	15.8	1.9
72436	10-26-83	.530	3.1	.86	3.5	.85	4.9	16.1	1.9
72486	11-08-83	.561	3.1	.93	3.5	.86	4.9	15.9	2.0
72487	10-22-83	.494	3.3	.88	3.5	.90	4.7	16.0	1.9
72512	11-25-83	.536	3.1	.88	3.6	.89	4.8	16.0	1.9
72593	12-04-83	.584	2.9	.87	3.6	.87	4.8	15.3	2.0
72594	12-07-83	.521	3.2	*.98	3.3	.88	4.8	15.6	1.9
72595	01-01-84	.556	3.1	.85	3.6	.89	4.7	15.9	1.9
72596	01-01-84	.570	3.0	.88	3.6	.93	4.6	15.6	2.0
72597	02-29-84	.569	3.1	.87	3.6	.86	4.9	16.1	1.9
72634	03-08-84	.531	3.2	.84	3.7	.89	4.8	15.7	1.9
72683	04-14-84	.517	3.2	.88	3.5	.86	4.9	15.9	1.9
72686	06-05-84	.537	3.1	.85	3.5	.87	4.7	16.3	1.9
73049	05-18-84	.481	3.4	.90	3.5	.90	4.6	15.3	2.0
73052	05-14-84	.501	3.3	.88	3.5	.82	5.0	15.6	1.9
73053	06-28-84	.533	3.2	.92	3.4	.88	4.8	15.6	1.9
73068	06-24-84	.522	3.2	.89	3.5	.92	4.7	15.7	1.9
73069	06-22-84	.577	3.1	.89	3.5	.95	4.5	15.8	2.0
73133	11-29-86	.506	3.4	.80	3.7	.87	4.8	15.6	1.9
73142	12-04-86	.514	3.4	.89	3.5	.86	4.9	15.9	1.9
73153	12-11-86	.533	3.3	.88	3.6	.85	5.0	15.7	1.9
73173	12-17-86	.536	3.3	.80	3.7	.93	4.5	15.3	1.9
73222	01-24-87	.496	3.5	.93	3.4	.91	4.6	15.4	2.0
73258	02-08-87	.522	3.3	.91	3.5	.84	5.0	15.0	2.0
73630	05-22-87	.561	3.3	.96	3.4	.89	4.8	15.8	2.0
73652	05-27-87	.581	3.2	.90	3.5	.87	4.9	16.6	1.9
73681	06-06-87	.572	3.2	.86	3.6	.84	5.1	16.0	1.9
73707	06-13-87	.530	3.3	.88	3.5	.87	4.8	15.7	1.9
73725	06-17-87	.497	3.5	.90	3.5	.87	4.8	16.0	1.9
73734	06-21-87	.518	3.4	.94	3.4	.87	4.9	16.1	1.9
73737	06-21-87	.529	3.3	.95	3.4	.91	4.7	15.3	2.0
73748	06-25-87	.515	3.4	.93	3.3	.94	4.5	16.4	1.9
73768	07-04-87	.525	3.3	.81	3.7	.87	4.9	15.0	1.9
73778	07-11-87	.491	3.5	.83	3.6	.91	4.6	16.1	1.9
73783	07-12-87	.496	3.5	.94	3.4	.84	5.0	15.9	1.9
73803	07-20-87	.564	3.2	.89	3.6	.90	4.7	16.0	1.9
73821	07-26-87	.480	3.6	.89	3.5	.92	4.7	15.2	2.0

*Result is outside QA limits.

Criterion 3: Recount samples if the activity of Cs or one of the natural radionuclides in the Hurricane reference soil differs from its mean by more than 2.50 times the standard deviation of the difference.

The rationale behind Criterion 3 is the same as that behind Criterion 2. The probability of a normally distributed variable being within 2.50 standard deviations of its mean is 0.9876; the probability that four independent variables will all be within such limits is $(0.9876)^4 = 0.9513$.

The calculations are similar to those for Criterion 2. The results (in pCi/g) are:

	^{137}Cs	^{238}U	^{232}Th	^{40}K
$\overline{X}$ (n=51)	0.534	0.876	0.877	15.78
s(X)	0.025	0.034	0.041	0.33
$\overline{X}$ - 2.50s(D)	0.472	0.792	0.777	14.96
$\overline{X}$ + 2.50s(D)	0.595	0.960	0.977	16.60

The data are plotted in Figure 5. Three results fall outside the limits: ^{238}U in samples 72213 and 72594 and ^{232}Th in sample 72421. The project leaders and scientific advisors reviewed the data for these samples and concluded that there was no need for recounts. Note that spurious uranium measurements can result from leakage of radon gas from an inadequately sealed sample bottle.

Duplicate Aliquots

A second important element of the QA program was the analysis of two aliquots prepared from the same sample. Duplicate aliquots, in the form of "B" bottles, were submitted in two groups: 33 in January 1984 and 22 in September 1984. The samples in the first group were chosen at random as part of the QA program, while the samples in the second group were chosen because other QA tests indicated possible problems with the results from the "A" bottles from several sites. The data are shown in Table 6.

Fourteen duplicates were submitted with the 1986–87 samples, but the QA criteria were not applied to these samples because only three (FM33–3, FM33–4, and NM22–1) were different aliquots ("B" bottles).

Criterion 4: Recount samples if the activities of Cs or one of the natural radionuclides in duplicate aliquots differ by more than 2.50 times the standard deviation of the difference.

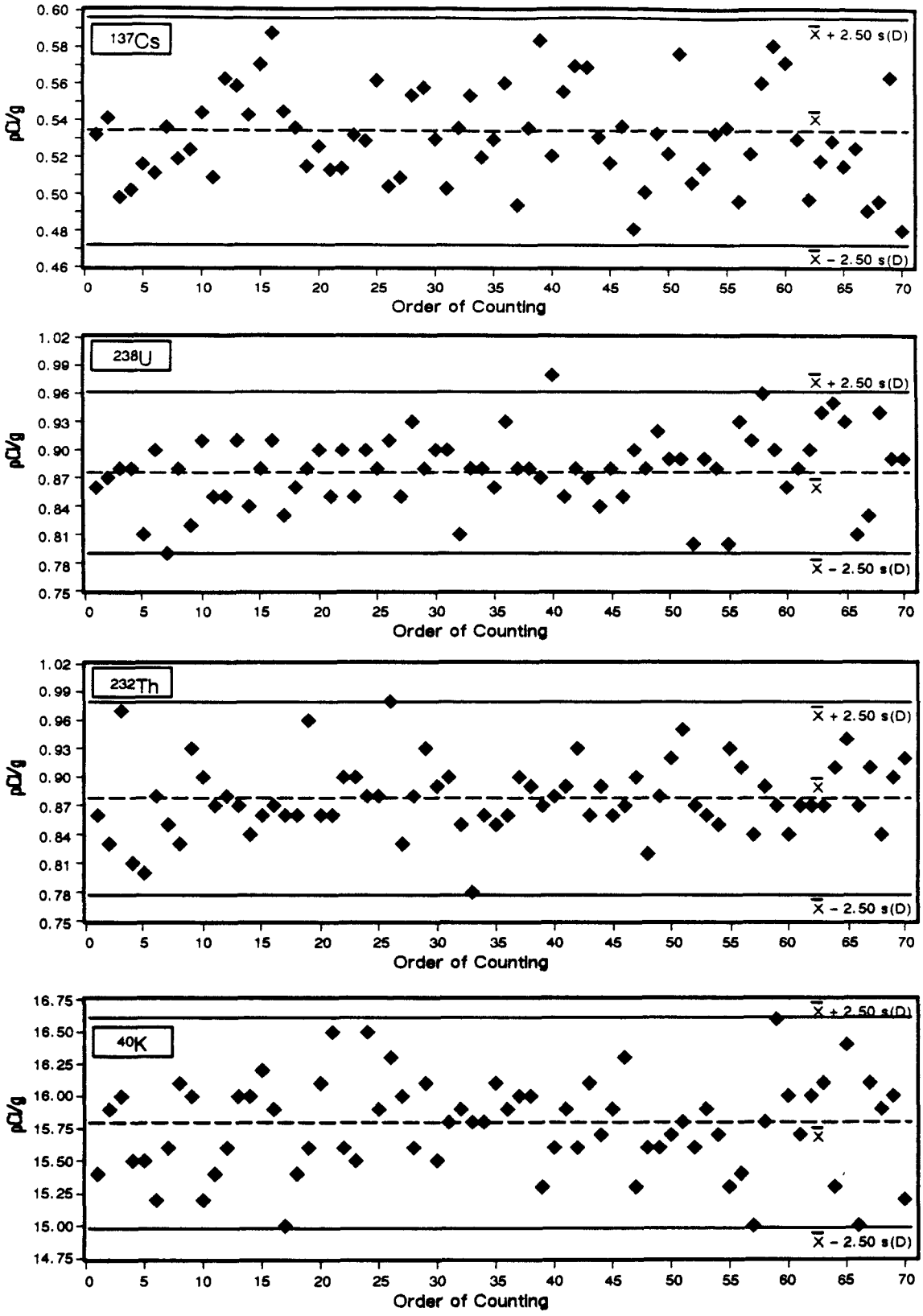

Figure 5. Measurements of ^{137}Cs and natural radionuclides in Hurricane soil.

TABLE 6 GAMMA-SPECTROMETRY RESULTS FOR DUPLICATE ALIQUOTS

Site	ID	Date	Concentration (pCi/g) and s d (%)							
			^{137}Cs		^{238}U		^{232}Th		^{40}K	
AS21-4	72411	**	064	6 9	1 13	1 1	1 10	1 5	16 3	7
	72618	03-28-84	058	19 5	1 21	3 0	1 09	4 2	16 6	2 0
AS35-1	72173	06-11-83	532	3 1	98	3 3	90	4 7	13 5	2 1
	72613	04-07-84	562	3 0	94	3 3	97	4 4	13 6	2 1
AS36-2	72164	05-26-83	819	2 5	1 10	3 2	96	4 7	13 2	2 2
	72625	03-24-84	825	2 5	1 09	3 2	87	5 1	13 7	2 2
AS43-3	72002	04-06-83	326	4 4	1 07	3 0	*1 16	3 9	16 4	1 8
	72617	03-29-84	329	4 5	1 05	3 1	* 98	4 5	16 1	1 9
	72002	06-30-85	339	4 3	1 01	3 2	1 11	4 1	16 0	1 9
	72617	07-07-85	293	5 0	1 02	3 1	1 17	3 9	16 0	1 9
BE25-2	72406	**	175	2 9	81	1 4	95	1 7	32 7	5
	72600	03-31-84	180	7 4	85	3 8	99	4 7	32 7	1 3
BF03-1	72459	11-17-83	428	3 8	1 04	3 3	1 12	4 1	15 6	2 0
	72621	03-29-84	467	3 6	1 11	3 1	1 12	4 2	15 0	2 0
DZ01-2	72252	07-28-83	446	3 5	90	3 4	97	4 3	16 8	1 8
	72602	04-01-84	444	3 5	87	3 4	1 00	4 3	16 8	1 8
DZ04-3	72224	07-02-83	251	6 0	3 12	1 7	1 10	4 6	14 2	2 2
	72630	03-25-84	295	5 4	3 20	1 7	1 23	4 3	14 8	2 2
DZ04-4	72233	07-26-83	* 024	43 1	1 66	2 4	1 03	4 5	13 5	2 1
	72627	03-24-84	* 134	9 0	1 71	2 4	1 06	4 3	13 7	2 1
	72233	07-05-85	042	25 0	1 67	2 4	1 02	4 4	13 8	2 1
	72627	07-07-85	051	21 9	1 64	2 5	1 01	4 7	13 5	2 2
DZ05-1	72201	06-18-83	556	3 2	*1 36	2 8	95	4 8	15 4	2 0
	72608	04-04-84	550	3 3	*1 50	2 6	97	4 8	15 8	2 0
	72201	07-06-85	561	3 2	1 45	2 6	1 11	4 3	15 5	2 0
	72608	07-07-85	576	3 2	1 38	2 8	1 05	4 4	16 0	2 0
DZ10-2	72192	06-18-83	1 130	2 1	94	3 8	86	5 2	13 3	2 3
	72598	03-30-84	1 086	2 2	95	3 8	85	5 2	13 6	2 3
DZ21-4	72210	06-29-83	119	10 0	1 17	2 9	1 05	4 2	15 2	2 0
	72633	03-26-84	110	10 6	1 15	3 0	1 00	4 4	15 0	2 0
FM33-2	72333	09-13-83	717	2 5	89	3 4	83	4 9	14 9	2 0
	72629	03-25-84	737	2 5	95	3 3	85	4 8	14 8	2 0
FM43-3	72423	10-17-83	* 273	5 2	1 02	3 3	1 03	4 3	12 8	2 2
	72623	03-23-84	* 346	4 2	96	3 4	1 02	4 3	12 9	2 2
	72423	07-30-85	299	4 9	98	3 4	1 11	4 1	12 8	2 2
	72623	07-07-85	283	5 1	1 02	3 2	1 08	4 1	12 8	2 2
FM45-2	72334	09-20-83	475	3 4	89	3 7	1 00	4 5	14 2	2 1
	72599	03-31-84	482	3 5	94	3 5	1 02	4 4	14 5	2 1
GC10-2	72277	08-22-83	345	4 8	1 46	2 9	1 27	4 0	19 8	1 9
	72609	04-04-84	360	4 7	1 55	2 8	1 25	4 0	20 2	1 9
GC19-4	72282	08-25-83	023	40 2	86	3 3	83	4 7	17 3	1 7
	72607	04-04-84	030	31 8	82	3 5	75	5 3	17 5	1 7
GC48-3	72267	07-30-83	273	5 0	1 18	2 9	1 16	4 0	18 9	1 7
	72615	04-07-84	271	5 0	1 18	2 9	1 12	4 1	19 8	1 7
KS10-4	72099	11-26-83	054	19 3	1 18	3 0	91	4 7	11 5	2 4
	72628	03-25-84	034	30 0	1 14	3 1	99	4 4	12 1	2 3
KS24-4	72370	10-14-83	071	13 8	67	4 1	67	5 6	13 0	2 1
	72601	03-31-84	083	12 6	72	4 0	71	5 4	13 2	2 1
KS25-2	72313	08-28-83	868	2 4	1 19	3 1	99	4 6	17 8	1 9
	72610	04-05-84	860	2 4	1 24	3 0	1 07	4 4	17 4	1 9
KS26-2	72391	10-13-83	835	2 5	1 24	3 1	1 03	4 6	18 5	1 9
	72632	03-25-84	861	2 5	1 30	3 0	1 06	4 6	19 1	1 8
KS27-3	72318	09-04-83	147	8 4	1 12	3 1	1 26	3 8	18 7	1 8
	72631	03-25-84	187	7 1	1 13	3 1	1 20	4 0	19 0	1 8
KS30-3	72354	10-15-83	145	7 6	* 62	4 3	62	5 9	13 5	2 0
	72620	03-28-84	158	7 1	* 77	3 7	61	6 0	13 6	2 0
	72354	06-14-87	128	9 0	65	4 1	68	5 5	14 0	2 0
	72620	06-07-87	130	8 8	65	4 1	60	5 9	13 7	2 0
MH14-2	72017	04-09-83	545	3 2	1 03	3 3	1 12	4 2	14 8	2 0
	72611	04-05-84	545	3 2	1 08	3 2	1 04	4 4	14 7	2 0
MH22-3	72032	03-08-83	051	18 9	59	4 6	61	6 3	23 7	1 5
	72605	04-04-84	075	13 3	55	4 7	69	5 5	23 4	1 5
MH25-4	72134	04-21-83	061	17 6	* 68	4 4	71	5 5	16 3	2 0
	72622	03-22-84	070	16 1	* 79	3 9	69	5 7	16 9	1 9
	72134	07-06-85	067	16 9	79	4 0	67	6 0	16 5	2 0
	72622	07-05-85	086	12 9	80	4 0	66	6 1	16 8	2 0
MH28-3	72155	04-30-83	253	5 2	63	4 6	62	6 0	15 5	2 0
	72626	03-24-84	257	5 3	62	4 6	57	6 4	15 2	2 0
RM08-2	72303	08-27-83	160	8 2	1 46	2 8	1 22	4 1	18 6	1 9
	72612	04-07-84	153	9 0	1 46	2 7	1 25	4 0	17 9	1 9

TABLE 6 GAMMA-SPECTROMETRY RESULTS FOR DUPLICATE ALIQUOTS (continued)

Site	ID	Date	Concentration (pCi/g) and s d (%)							
			^{137}Cs		^{238}U		^{232}Th		^{40}K	
RM10-1	72020	04-07-83	406	4 0	1 24	3 0	1 20	4 0	18 0	1 9
	72614	04-07-84	439	3 8	1 20	3 1	1 24	4 0	18 5	1 9
RM12-4	72050	03-11-83	080	14 8	1 37	2 8	1 59	3 4	*20 2	1 8
	72606	04-04-84	070	17 9	1 47	2 8	1 68	3 3	*21 5	1 7
	72050	12-14-86	067	19 3	*1 26	3 0	1 53	3 5	20 7	1 7
	72606	06-11-87	072	18 4	*1 49	2 7	1 57	3 4	21 1	1 7
RM19-2	72065	**	290	2 7	2 90	9	1 29	2 0	22 0	8
	72619	03-28-84	290	5 5	2 94	1 8	1 27	4 2	22 5	1 7
SW05-2	72047	03-09-83	* 293	5 1	1 30	2 9	1 09	4 3	14 9	2 1
	72603	04-02-84	* 448	3 7	1 23	3 0	99	4 7	14 5	2 2
	72047	07-04-85	347	4 6	*1 30	2 9	1 09	4 3	14 8	2 1
	72603	07-06-85	335	4 8	*1 16	3 2	1 05	4 4	14 9	2 1
DZ16-1	72105	06-13-83	742	2 6	1 17	3 1	1 10	4 3	15 3	2 1
	73095	09-26-84	760	2 6	1 11	3 2	1 03	4 5	14 4	2 1
DZ16-2	72108	06-14-83	249	5 7	1 07	3 2	1 54	3 4	20 3	1 7
	73091	09-25-84	297	5 1	95	3 6	1 49	3 4	19 2	1 8
DZ16-3	72114	06-14-83	272	5 3	*1 12	3 2	1 42	3 6	17 9	1 8
	73097	09-27-84	236	5 9	* 94	3 5	1 41	3 6	16 9	1 9
	72114	07-05-85	233	6 2	1 07	3 2	1 43	3 5	17 4	1 9
	73097	07-10-85	256	5 7	1 06	3 2	1 42	3 6	17 2	1 9
DZ16-4	72115	06-14-83	065	14 7	1 00	3 1	71	5 3	8 2	2 7
	73096	09-26-84	062	15 8	93	3 3	65	5 6	8 1	2 7
E20A-1	72476	12-01-83	447	3 4	82	3 6	70	5 5	16 9	1 8
	73103	09-29-84	418	3 8	76	3 8	62	6 0	16 2	1 9
E20A-2	72471	11-30-83	454	3 5	86	3 5	72	5 5	17 8	1 8
	73107	09-30-84	463	3 4	76	3 9	72	5 5	17 3	1 8
E20A-3	72483	12-03-83	307	4 5	82	3 7	81	5 1	17 6	1 8
	73106	09-30-84	290	4 8	85	3 5	73	5 4	17 5	1 8
E20A-4	72472	01-09-84	056	18 8	86	3 5	80	5 2	*19 8	1 7
	73093	09-26-84	076	13 7	82	3 6	76	5 3	*18 2	1 8
	72472	06-15-87	077	14 5	85	3 5	77	5 2	19 2	1 7
	73093	06-17-87	086	13 1	91	3 4	83	4 9	18 5	1 8
E35-1	72479	12-01-83	412	3 5	56	4 6	48	7 3	11 4	2 2
	73099	09-27-84	363	3 9	52	4 8	50	6 7	10 7	2 3
E35-2	72467	01-02-84	353	3 9	59	4 3	56	6 1	*12 0	2 1
	73108	09-30-84	343	4 0	58	4 4	52	6 5	*11 1	2 3
	72467	07-06-85	364	3 9	55	4 6	55	6 2	11 6	2 2
	73108	07-12-85	360	3 9	61	4 2	55	6 5	11 3	2 2
E35-3	72481	01-02-84	242	5 1	60	4 3	57	6 0	11 8	2 2
	73104	09-29-84	253	4 8	55	4 6	53	6 6	11 2	2 2
E35-4	72480	01-04-84	* 104	9 3	60	4 3	55	6 3	12 4	2 1
	73087	09-21-84	* 066	15 2	59	4 4	59	6 0	12 7	2 1
	72480	07-06-85	075	13 9	64	4 0	61	5 7	13 1	2 1
	73087	07-07-85	089	11 4	59	4 4	55	6 5	13 0	2 1
KS01-2	72049	03-10-83	* 445	3 7	*1 13	3 2	*1 08	4 2	16 6	2 0
	73098	09-27-84	* 386	4 3	* 99	3 5	* 90	4 9	16 0	2 1
	72049	07-04-85	466	3 6	1 06	3 3	98	4 7	16 7	2 0
	73098	07-11-85	423	4 0	1 11	3 2	1 04	4 5	16 0	2 0
KS01-3	72059	03-11-83	197	6 7	1 09	3 3	* 94	4 7	16 5	2 0
	73088	**	202	4 8	1 01	2 4	*1 09	3 0	15 9	1 4
	72059	07-04-85	197	7 0	1 07	3 4	1 07	4 4	16 9	2 0
	73088	07-08-85	201	6 9	1 08	3 3	1 08	4 3	16 3	2 0
KS01-4	72066	03-26-83	063	18 3	1 26	3 1	1 15	4 2	*17 7	2 0
	73101	09-28-84	049	23 7	1 18	3 2	1 03	4 6	*16 1	2 1
	72066	07-04-85	063	19 3	1 22	3.1	1 10	4 4	17 7	2 0
	73101	07-13-85	057	21 2	1 26	3 1	1 14	4 2	16 8	2 0
MH07-1	72025	04-10-83	* 793	2 6	*1 30	2 9	1 60	3 3	*20 8	1 7
	73089	09-24-84	* 334	4 6	*1 07	3 2	1 59	3 3	*19 4	1 8
	72025	07-03-85	812	2 6	1 42	2 7	1 58	3 4	20 9	1 7
	73089	07-09-85	746	2 8	1 39	2 8	1 58	3 4	20 7	1 7
MH07-2	72031	04-10-83	* 469	3 7	1 46	2 7	1 92	3 0	22 7	1 6
	73100	09-27-84	* 545	3 4	1 47	2 7	1 73	3 2	21 5	1 7
	72031	06-30-85	481	3 8	1 58	2 6	1 94	3 0	23 6	1 6
	73100	07-11-85	531	3 5	1 55	2 6	1 81	3 1	22 6	1 6
MH07-3	72027	04-10-83	254	5 9	1 35	2 9	1 79	3 2	23 3	1 6
	73094	09-26-84	301	5 3	1 49	2 7	1 81	3 1	23 0	1 6
MH07-4	72008	03-23-83	087	14 5	1 58	2 6	*2 04	2 9	*23 8	1 6
	73090	09-24-84	087	14 8	1 51	2 6	*1 72	3 2	*22 3	1 6
	72008	06-30-85	093	14 4	1 53	2 6	1 83	3 1	22 9	1 6
	73090	07-09-85	057	23 0	1 50	2 6	1 81	3 1	23 0	1 6
MH22-1	72016	02-17-83	1 779	1 5	75	4 1	96	4 6	19 1	1 7
	73092	09-25-84	1 770	1 6	70	4 4	86	5 1	18 8	1 8
MH22-2	72004	03-07-83	203	6 1	64	4 2	68	5 6	21 7	1 6
	73105	09-29-84	215	5 9	64	4 3	73	5 3	21 9	1 6

TABLE 6. GAMMA-SPECTROMETRY RESULTS FOR DUPLICATE ALIQUOTS (continued)

Site	ID	Date	Concentration (pCi/g) and s d (%) ^{137}Cs		^{238}U		^{232}Th		^{40}K	
MH22-4	72023	**	012	39 3	* 42	2 7	* 54	3 1	*24 1	7
	73102	09-29-84	024	39 1	* 69	4 0	* 85	4 8	*22 0	1 6
	72023†	06-28-85	015	38 4	* 43	3 1	* 52	3 7	*23 9	8
	73102†	06-29-85	007	85 3	* 68	2 2	* 86	2 6	*21 8	9
FM35-1	72523	02-21-84	837	2 5	86	4 0	64	6 2	10 9	2 6
	73134	11-30-86	818	2 7	81	4 2	62	6 5	10 4	2 6
FM35-2	72537	02-26-84	475	3 3	84	3 5	96	4 4	14 1	2 0
	73131	11-29-86	481	3 4	94	3 3	85	4 8	13 9	2 0
FM35-3	72535	02-25-84	187	6 6	89	3 4	99	4 3	15 3	1 9
	73150	12-06-86	162	7 7	86	3 5	94	4 5	14 5	2 0
FM35-4	72515	03-11-84	031	30 8	78	3 6	87	4 6	18 0	1 7
	73149	12-06-86	040	24 9	71	4 0	83	4 9	17 6	1 7
FM33-1	72331	09-13-83	698	2 8	71	4 5	60	6 4	9 3	2 8
	73245	02-03-87	653	3 1	79	4 1	56	6 9	8 9	2 9
FM33-2	72629	03-25-84	737	2 5	95	3 3	85	4 8	14 8	2 0
	73252	02-07-87	697	2 7	89	3 5	80	5 2	14 7	2 0
FM33-3	72345	09-19-83	178	6 7	82	3 5	87	4 7	17 3	1 8
	73213	01-21-87	205	6 3	81	3 6	93	4 4	16 6	1 8
FM33-4	72340	09-26-83	053	17 9	90	3 3	97	4 4	18 0	1 7
	73236	01-29-87	040	25 2	85	3 4	95	4 4	17 7	1 7
DZ10-1	72212	06-26-83	3 084	1 2	94	4 1	91	5 3	13 6	2 3
	73164	12-14-86	3 084	1 3	97	3 9	84	5 5	13 1	2 4
RM02-3	72012	02-16-83	122	9 5	1 21	2 9	1 28	3 8	22 7	1 6
	73158	12-13-86	112	11 5	1 21	2 9	1 28	3 8	20 8	1 7
RM12-4	72050	03-11-83	080	14 8	1 37	2 8	1 59	3 4	20 2	1 8
	73165	12-14-86	067	19 3	1 26	3 0	1 53	3 5	20 7	1 7
DZ10-2	72192	06-18-83	1 130	2 1	94	3 8	86	5 2	13 3	2 3
	73181	12-21-86	1 120	2 2	1 03	3 6	89	5 1	13 7	2 3
SW05-4	72038	02-17-83	- 006	191 0	1 59	2 5	1 62	3 4	21 0	1 7
	73247	02-03-87	005	241 0	1 52	2 6	1 72	3 2	21 4	1 7
NM22-1	73809	07-21-87	336	4 7	1 37	2 6	99	4 5	18 4	1 8
	73798	07-19-87	346	4 4	1 34	2 6	95	4 6	18 1	1 8

*These results fail the QA criterion
**Variance-weighted average of multiple counts
†1000-minute counts

The standard deviation here is based on the counting error only. An example of the calculations is shown for sample FM43-3:

#72423: Cs = 0.273 pCi/g with 5.2% s.d.

#72623: Cs = 0.346 pCi/g with 4.2% s.d.

$s_1 = 0.273 \times 0.052 = 0.0142$

$s_2 = 0.346 \times 0.042 = 0.0145$

$D = 0.346 - 0.273 = 0.073$

$s(D) = \sqrt{s_1^2 + s_2^2} = 0.0203$

$2.50 \times s(D) = 0.051$

The difference is greater than 2.5 standard deviations, so the sample fails the test.

An analysis of the results in June 1985 found six samples in the first group that failed one of the four tests and ten samples in the second group that failed at least one test. All 16 pairs of aliquots were submitted for recounting. A repeat of the calculations in

November 1986 found three more samples (KS30-3, RM12-4, and E20A-4) that failed one of the tests. The six bottles from these samples were recounted with the 1986-87 samples.

The results of the recounts show three pairs, SW05-2, MH22-4, and RM12-4, that fail at least one test. (SW05-2 and RM12-4 fail a different test from the one they failed originally.) Because most of the discrepancies involved ^{238}U measurements, which can be inaccurate if the sample is not in equilibrium, new aliquots of these samples were not prepared. After examination of the results by project scientists, all counts except the first count of 72603 from SW05-2 were accepted as valid.

The recounts of the other 16 pairs agreed with each other. According to the QA plan, the first counts of these samples should be disregarded, but this was only the case for 72627 (DZ04-4), 72480 (E35-4), 72623 (FM43-3), 73098 (KS01-2), and 73089 (MH07-1). All other results were accepted as valid. The high rejection rate (19 of 55 = 35%) of the duplicate analyses is somewhat disturbing. However, only 8 of the 33 randomly-chosen pairs failed, and 3 of those failures were due to differences in the ^{238}U values. The other 22 pairs were chosen because of problems with the initial results, so a high rejection rate is not surprising. It should also be noted that the QA test was based only on the counting error, not on the total analytical variability, and it may therefore have been too stringent.

Other Criteria

Four additional criteria were specified to check the consistency of the gamma results from the four increments at a given site. Sites that failed to meet one of these criteria were "flagged" in the database and thus called to the attention of the project scientists. They reviewed the records of the samples in question to make sure that no errors had been made in recording or calculating, and then ordered recounts or realiquoting if they felt it was necessary.

Criterion 5: Flag the results for a site if the Cs does not decrease with depth.

Forty-five sites were flagged by this criterion:

AF02	BE40	FM14	GC23	MH11
AS01	BF03	FM17	GC29	RM14
BA15	BF09	FM33	KM28	SA20
BE01	E3	FM50	KS25	SA26

BE06	E20A	GC08	KS34	SH07
BE34	E26A	GC19	MH02	SW06
AQ07	AQ08	AQ09	AQ12	AQ13
AQ25	AQ26	AQ32	AQ33	FM34
NM01	NM12	NM23	NM24	NM26

The QA plan also calls for flagging the results if the Cs does not approach zero at a depth of 30 cm, but it does not define precisely what is meant by "approach zero." This part of the criterion was applied by fitting the data to an exponential depth distribution and calculating the theoretical inventory as a function of depth. If this calculation showed that a large fraction of the theoretical inventory was below 30 cm, the site was flagged as one where the Cs apparently penetrated deeply into the soil.

Criterion 6: Flag the results for a site if the total Cs is less than 60% of that expected from global fallout.

This criterion and a similar one for total Pu were based on an alternative method used by EML to estimate global fallout in Utah. This method was not formally applied to the ORERP results, though rough approximations were used to help evaluate some sites. Details will be given in Anspaugh and Beck (1989).

Criterion 7: Flag the results for a site if the total Cs differs from the *in situ* measurement by more than 30%.

The *in situ* spectra were not analyzed to estimate Cs inventories because several detectors were used and they were calibrated differently. An empirical calibration was used to flag some sites where the *in situ* results were clearly inconsistent with the soil analyses. This will be explained further in Anspaugh and Beck (1989).

Criterion 8: Flag the results for a site if the variation of natural gamma activity with depth in the soil is inconsistent with the internal norms established by estimating the empirical distributions of the variance of natural activity within a soil core.

The variance of the activity within a soil profile (each profile is a composite of 10 soil cores) is estimated by the formula

$$V = \sum_i X(i)^2 - [\sum_i X(i)]^2/4]/3$$

where X(i) is the activity in increment i. This variance was computed for each of the three natural gamma-emitting radionuclides at each of 212 sites. (Site MH02 was omitted be-

cause it has five increments.) Histograms of the values of V (Figure 6) show their empirical distributions. The values that are too large to be shown in Figure 6 are listed below.

	Variance	Site		Variance	Site
^{238}U	0.520	DZ04	^{40}K	107.2	BE09
	0.196	BE06		29.4	GC29
	0.195	KS36		25.0	DZ16
				25.0	BE25
^{232}Th	0.144	DZ16		24.2	AQ33
	0.138	RM14		21.2	KM29
				20.1	DZ04A
				19.9	NM13
				19.2	AQ08
				18.9	SH10
				18.0	SW05

No standards were specified for deciding which values of the variances are "inconsistent" with the empirical distributions. This criterion was applied semi-quantitatively to identify possible disturbed sites or sample switches.

Plutonium Analyses

The 671 plutonium analyses were done in 66 separate batches. A summary of the batches and the QA samples they contained is given in Table 7.

QA samples analyzed for plutonium included 139 samples of reference soils. A third reference soil (EML #2328) was used along with the same Hurricane and blank soil used in the gamma analyses. This soil was collected by EML at North Eastham, Massachusetts, in October 1978. Note that the blank soil was only blank for Cs; it contained small but measurable amounts of plutonium.

The first five batches to be analyzed were rejected by committee decision rather than by specific QA criteria, which did not exist at that stage of the project. The decision was based in part on the QA results, but also took into account the reproducibility of the results at REECo and comparisons with EAL analyses of duplicate aliquots. The difficulties with these first batches demonstrated the need for specific criteria for accepting results and led to the development of the formal QA plan.

Checks on Individual Analyses

Four criteria were specified to ensure that each sample had been prepared and counted properly.

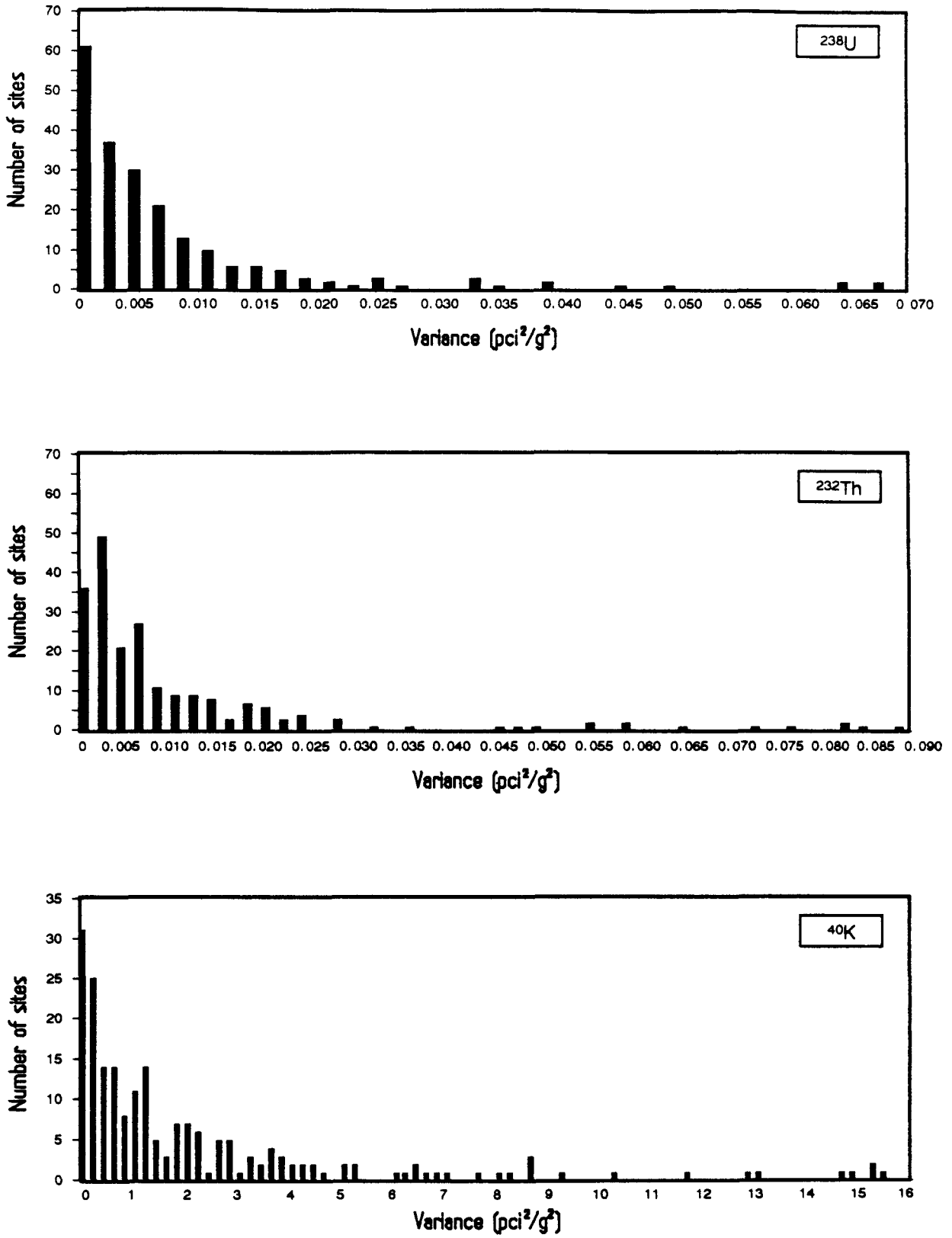

Figure 6. Variances of natural radionuclides.

TABLE 7. PLUTONIUM BATCHES

Batch #	Date	# of samples	QA samples Hurr	EML	Blank	Dup	Comments
1	7/83	8	X	X		*	Rejected
1A	2/84	10	X	X	X	X	
2	8/83	8	X	X			Rejected
2A	10/83	9	X	X	X		Rejected
2B	11/83	9	X	X	X		
2E	11/83	9	X	X	X		Analyzed at EAL, not used
3	8/83	7	X	X		*	Rejected
3A	2/84	10	X	X	X	X	
4	8/83	8	X	X			Rejected
4A	2/84	10	X	X	X	X	Rejected, Hurricane high
5	9/83	8	X				
6	9/83	8	X	X		*	
7	10/83	9	X	X		*	
8	10/83	8	X				
9	11/83	10	X	X	X		
10	2/84	10		X	X		
11	3/84	10	X	X			
12	3/84	10		X	X	X	
13	3/84	10		X	X	X	
14	4/84	10	X	X	X		
15	4/84	10		X	X	X	
16	5/84	10	X		X	X	
17	5/84	10	X	X		X	Rejected - EML reference high
18	5/84	10	X		X	X	Rejected - Hurricane low, blank high
19	5/84	10	X	X		X	
20	6/84	10	X		X	X	
21	6/84	10	X	X		X	Rejected - Hurricane high
22	7/84	10	X	X		X	
23	7/84	10	X	X		X	
24	8/84	10	X		X	X	
25	9/84	10	X		X	X	
26	9/84	10	X		X	X	
27	10/84	10	X	X	X		
28	10/84	10	X		X	X	
29	10/84	10	X		X	X	Rejected - blank high
30	10/84	10	X		X	X	Rejected - Hurricane high
31	11/84	10	X		X	X	Rejected - blank high
32	11/84	10	X		X	X	Rejected - blank high
33	1/85	10	X		X	X	Rejected - Hurricane low
34	1/85	10	X		X	X	
35	1/85	10	X		X	X	Rejected - blank high
36	1/85	10	X		X	X	
37	2/85	10	X		X	X	
38	3/85	10	X		X	X	Rejected - blank high
39	3/85	10	X		X	X	
40	4/85	10	X		X		
41	8/85	25	X		X		Analyzed at EAL
42	8/85	25	X		X		Analyzed at EAL
43	2/86	10	X		X		
44	2/86	10	X			*	
45	1/87	10	X		X	X	
46	2/87	10	X		X	X	
47	2/87	10	X		X		
48	3/87	10	X		X	X	
49	3/87	10	X			X	
50	3/87	10	X				
51	5/87	10	X		X		
52	5/87	10	X		X	X	
53	5/87	10	X			X	
54	6/87	10	X		X	X	
55	8/87	10	X			X	
56	8/87	10	X		X		
57	9/87	10	X		X		
58	9/87	10	X		X		Rejected - blank high
59	9/87	10	X		X		
60	10/87	10	X		X		

* = duplicate of QA sample

Criterion 9: Discard the aliquot if the recovery of the ^{236}Pu tracer is less than 30%.

Tracer recoveries were not reported for the first 14 batches. In the remaining batches, 21 samples were reported with low recoveries:

ID	Batch	% recovery	New ID
73367	23	24	73492
73419	28	19	73551
73420	28	29	73488
73421	28	13	73484
73490	35	22	73625
73505	37	27	73599
73509	37	7	73581
73510	37	25	73597
73511	37	22	QA sample
73513	37	28	73557
73527	39	7	73598
73528	39	27	73578
73530	39	29	73577
73531	39	25	duplicate
73542	40	21	73559
73543	40	24	73595
73564	41	24	QA sample
73585	42	25	73622
73586	42	27	73616
73925	53	25	---
73969	58	29	QA sample

All were realiquoted and reanalyzed except for four QA samples and one sample from Albuquerque that was judged to be of little importance because of samples from nearby locations.

Criterion 10: Recount the sample if the resolution of the alpha spectrum is greater than 80 keV at full width half maximum (FWHM).

The Pu FWHM was not reported for the three batches analyzed at EAL. It was also not reported for 63 samples with low Pu levels (about half of these were samples of blank soil).

The samples reported with resolutions greater than 80 keV are shown below (n.r. = resolution not reported). There is no evidence that any recounts were ordered because of poor resolution.

ID	Batch	Resolution (keV) Count 1	Count 2	Count 3	Count 4
72845	5	98	n.r.	---	---
72851	5	89	n.r.	---	---
72829	6	95	n.r.	---	---
72807	9	93	80	---	---
72745	11	90	47	---	---
72706	15	46	89	---	---
73304	17	49	82	---	---
73494	36	51	75	67	84
73502	36	81	77	58	55
73506	37	75	82	---	---
73507	37	61	85	---	---
73541	40	46	88	---	---

Criterion 11: Do more chemistry if the alpha spectrum contains peaks of other radionuclides in the 5 to 6 meV range.

No such problems were ever reported to the QA referee by any of the laboratories involved with the plutonium analysis.

Criterion 12: Recount the disk if the difference between the first two counts exceeds 1.96 times its standard deviation.

The calculation here is similar to that of Criterion 4 for the gamma analyses. The value of 1.96 gives a five percent chance of incorrectly ordering a recount under the assumption of normality.

Criterion 12 was applied to all 565 samples that were counted at least twice. Those that failed are listed in Table 8. Of the 453 non-QA samples, 32 (7%) failed the test. Not all of these were recounted: Some were rejected because of low recovery, others were from rejected batches and were thus reanalyzed automatically, and others were sent for IMS before the test was applied. Eleven of the 112 QA samples (10%) also failed to meet this criterion.

Reference Samples

Criterion 13: Reject a batch if results for reference soils or blank soil fall outside the range of acceptability.

The QA plan specified four statistical tests to decide if a standard differs too much from its mean (Test 1), if both standards are too low (Test 2) or too high (Test 3) simulta-

TABLE 8. SAMPLES THAT FAIL CRITERION 12

ID	Count 1 Pux100	Count 1 %s.d.	Count 2 Pux100	Count 2 %s.d.	D/s(D)	Comments
72735	2.69	6.0	2.18	6.4	2.39	Recounted
72741	1.24	6.3	0.987	7.2	2.40	Recounted
72867	3.55	4.5	4.03	4.6	-1.96	Batch rejected
72868	0.300	17.0	0.480	14.0	-2.13	Batch rejected
72883	4.55	4.1	3.80	5.2	2.76	Batch rejected
72885	1.67	6.3	2.04	6.3	-2.23	
73305	0.800	7.7	0.620	8.8	2.19	Batch rejected
73352	0.180	14.2	0.260	12.0	-1.98	
73369	0.438	9.5	0.581	8.5	-2.21	Recounted
73381	1.24	6.6	1.49	6.4	-1.99	
73383	3.53	5.5	4.39	5.9	-2.66	
73388	0.540	9.2	0.336	11.0	3.29	Recounted
73421	3.69	10.9	5.30	12.9	-2.03	Low recovery
73445	0.210	14.9	1.68	14.9	-5.83	Batch rejected
73451	0.040	48.1	1.99	8.0	-12.16	Batch rejected
73465	0.830	7.3	0.670	7.7	2.01	Batch rejected
73473	0.590	9.1	0.760	8.4	-2.04	Batch rejected
73486	-0.009	120.0	0.048	37.4	-2.72	Batch rejected
73498	0.793	7.2	0.615	7.8	2.39	Recounted
73513	4.47	7.8	3.18	7.4	3.07	Low recovery
73542	0.620	14.2	0.400	16.8	1.99	Low recovery
73552	1.72	7.0	2.04	5.0	-2.03	
73579	0.730	6.0	0.880	7.0	-1.98	
73206	10.1	5.3	8.54	4.8	2.31	Recounted
73268	11.4	5.0	9.10	5.2	3.10	Recounted
73275	0.506	10.1	0.675	9.2	-2.10	Recounted
73280	0.638	8.5	0.821	7.9	-2.16	Recounted
73281	5.70	5.2	4.68	5.3	2.64	
73910	0.557	9.5	0.716	8.5	-1.97	Recounted
73913	3.36	6.6	2.57	6.5	2.85	
73933	13.0	6.4	18.3	6.4	-3.69	
73898	0.403	9.3	0.268	11.4	2.79	Recounted
Hurricane soil						
72858	4.09	4.5	3.61	4.4	1.97	Recounted
73343	6.81	6.1	3.75	7.0	6.23	
73417	3.56	5.6	4.31	5.6	-2.40	
73444	4.71	5.0	3.59	5.8	3.56	
73200	3.61	5.0	4.18	4.9	-2.09	
73917	4.01	5.8	2.98	5.8	3.55	Recounted
Blank soil						
72756	0.0370	31.0	-0.0009	65.9	3.30	
72730	0.0660	28.0	-0.0112	131.8	3.26	
72692	0.0570	30.0	-0.0091	132.7	3.16	
73436	0.0365	47.5	0.0913	22.7	-2.03	
73512	0.0329	32.8	-0.0003	71.9	3.08	

neously, and if the blank is too high (Test 4). However, these tests pertain only to batches that contain both reference soils (21 of the 60), and there is no evidence that they were actually applied to any of the results during the course of the project. The criteria computed below are those actually used to accept or reject the different batches.

The range of acceptability is defined as $\overline{X} \pm 1.96s$ for the Hurricane and EML reference soils and as less than $\overline{X} + 2.33s$ for the blank soil. The rate of false rejection is 5% for each of the reference soils and 1% for the blank soil.

Most of the reference samples were counted two or three times; the variance-weighted average of the multiple counts was used in calculating the means and standard deviations of the three soil types. The results from batch 2E were excluded from the

calculations, as were results that led to rejection of a batch. In the following discussion and tables, the activities of the reference soils are multiplied by 100 and those of the blank soil are multiplied by 10,000.

The data for the 65 Hurricane samples are given in Table 9. Excluding the values from batches 1 (#72856), 2, 2A, 2E, 4A, 21, 30, 33, and 45 through 60, the average of the remaining 41 samples is 4.07 with a standard deviation of 0.36. The QA limits are 3.36 and 4.78.

Data for the 27 samples of EML reference soil are given in Table 10. The results from batches 2A, 2E, and 17 are excluded; the remaining 24 samples have a mean of 1.22 and a standard deviation of 0.073. The QA limits are 1.07 and 1.36.

Table 11 gives the results for the 47 samples of blank soil. The results from batches 2E, 18, 29, 31, 32, 35, 38, and 41 and the batches analyzed in 1987 were deleted and the mean and standard deviation of the remaining 27 samples were computed to be 2.45 and 1.70. The calculated QA limit is 6.42.

The data from all three soil types are plotted with their QA limits in Figures 7 through 9.

There are slight differences between the control limits calculated here and those used at intermediate stages of the project. The computed means and standard deviations naturally varied as more data were added, and the limits for the two reference soils were calculated from the 5% level of the t-distribution instead of the normal distribution. Thus the EML reference soil in batch 3A is outside the control limits in Figure 9 but was within the limits based on an earlier value of the standard deviation.

Also, the decision to accept or reject a batch was often based on the first count only. Thus batch 21 was rejected on the basis of the Hurricane sample even though the average of the two counts is within the QA limits.

The samples in all but three of the rejected batches were realiquoted and resubmitted in later batches. Batches 46, 47, and 54 were not redone because the samples in those batches were deemed to be of minor importance.

Other Criteria

Additional criteria were specified to check the consistency of the plutonium results with the expected results. Results that failed one of these tests were flagged and examined carefully before being accepted or rejected.

TABLE 9. CONCENTRATION OF $^{239+240}Pu$ (dpm/g x 10^2) IN HURRICANE SOIL

Batch #	ID	Count 1 Date	Count 1 Pu	Count 1 %s.d.	Count 2 Date	Count 2 Pu	Count 2 %s.d.	Mean
1	72856	07-02-83	8.29	4.3	--	--	--	8.29
	72886	07-08-83	3.75	4.4	11-11-83	3.85	4.7	3.80
2	72866	08-09-83	2.02	5.9	--	--	--	2.02
3	72864	08-19-83	3.63	4.6	11-14-83	3.80	4.7	3.71
	72876	08-21-83	4.30	5.1	--	--	--	4.30
4	72858	08-29-83	4.09	4.5	11-14-83	3.61	4.4	3.76*
5	72850	09-04-83	4.06	5.0	11-11-83	4.00	5.5	4.02*
6	72833	09-04-83	3.80	5.1	11-08-83	3.92	5.5	3.85
8	72853	10-25-83	3.94	4.3	11-14-83	3.67	4.4	3.80
7	72834	10-29-83	4.26	4.5	11-08-83	4.35	4.6	4.30
9	72809	11-08-83	4.32	5.8	04-02-85	4.74	6.5	4.49
2A	72815	not reported			--	--	--	--
2B	72798	11-23-83	3.89	5.2	--	--	--	3.89
2E	72791	--	3.485	--	--	--	--	3.485
3A	72760	02-01-84	3.93	6.4	--	--	--	3.93
1A	72763	02-03-84	4.65	4.5	--	--	--	4.65
4A	72775	02-18-84	5.35	4.6	--	--	--	5.35
11	72746	03-11-84	3.84	4.7	03-29-85	3.93	5.4	3.88
14	72728	04-13-84	3.89	5.2	03-30-85	3.68	5.6	3.79
18	73317	05-08-84	2.03	6.2	06-22-84	2.06	6.0	2.05
16	72695	05-12-84	4.67	6.9	04-06-85	4.06	5.3	4.25
17	73300	05-18-84	3.86	5.4	04-04-85	3.81	5.8	3.84
19	73325	05-23-84	4.30	4.8	02-10-85	4.35	4.9	4.32
20	73338	06-16-84	4.10	4.4	02-10-85	4.02	4.7	4.06
21	73343	06-27-84	6.81	6.1	04-20-85	3.75	7.0	4.62
22	73359	07-02-84	4.54	4.7	02-15-85	4.40	5.0	4.47
23	73361	07-17-84	3.64	5.8	02-15-85	4.02	6.2	3.80
24	73371	08-29-84	4.40	6.9	01-27-85	4.50	7.5	4.44
25	73386	09-08-84	3.97	5.0	01-22-85	3.91	5.1	3.94
26	73394	09-18-84	3.93	4.9	02-10-85	4.14	5.1	4.03
27	73405	10-13-84	4.17	4.8	04-21-85	4.63	5.0	4.37
28	73417	10-20-84	3.56	5.6	02-17-85	4.31	5.6	3.86
29	73427	10-30-84	4.15	5.8	02-11-85	4.11	6.0	4.13
30	73438	10-31-84	6.72	4.8	04-19-85	7.17	5.0	6.92
31	73444	11-04-84	4.71	5.0	04-20-85	3.59	5.8	4.08
32	73461	11-05-84	3.89	5.4	02-11-85	3.61	5.5	3.74
33	73464	01-08-85	3.12	5.3	01-19-85	3.14	5.3	3.13
34	73477	01-23-85	3.65	4.9	01-24-85	3.51	4.9	3.69*
35	73491	01-26-85	3.59	5.3	01-29-85	3.57	5.2	3.55*
36	73500	01-28-85	3.56	4.8	01-30-85	3.60	4.8	3.55*
37	73511	02-27-85	3.89	8.9	03-03-85	4.08	9.3	3.98
38	73523	03-10-85	4.55	6.0	03-12-85	4.55	5.9	4.55
39	73525	03-27-85	3.77	5.2	04-09-85	3.92	5.2	3.84
40	73536	04-10-85	4.02	5.2	--	--	--	4.02
41	73573	--	4.09	5.0	--	--	--	4.09
42	73594	--	3.74	4.0	--	--	--	3.74
43	73610	02-09-86	4.67	4.7	02-24-86	4.73	4.9	4.70
44	73618	02-13-86	4.37	5.0	02-21-86	4.30	5.2	4.34
	73624	02-13-86	3.96	5.3	02-21-86	3.69	5.0	3.81
45	73189	01-17-87	3.92	5.9	02-20-87	4.55	6.2	4.17
46	73200	02-03-87	3.61	5.0	02-21-87	4.18	4.9	3.86
47	73209	02-04-87	4.05	5.7	02-21-87	4.32	5.9	4.17
48	73261	03-13-87	3.64	5.4	03-21-87	3.40	5.2	3.51
49	73273	03-23-87	4.93	7.3	03-26-87	4.06	6.9	4.39
50	73282	03-21-87	4.18	5.3	03-24-87	4.30	5.5	4.24
51	73907	05-02-87	3.98	5.3	05-08-87	3.78	5.5	3.88
52	73917	05-07-87	4.01	5.8	05-10-87	2.98	5.8	3.66*
53	73921	05-09-87	3.67	6.8	05-12-87	3.86	6.9	3.76
54	73930	06-04-87	4.24	7.5	06-10-87	4.11	7.3	4.17
55	73947	08-24-87	4.08	5.1	08-25-87	4.01	4.9	4.04
56	73952	08-28-87	4.20	5.6	09-01-87	4.44	5.3	4.32
57	73961	09-08-87	3.97	5.6	09-15-87	3.73	5.6	3.84
58	73971	09-14-87	4.37	5.8	09-16-87	3.85	5.8	4.08
59	73984	09-26-87	4.33	5.4	09-28-87	3.81	5.0	4.02
60	73894	10-18-87	3.92	5.0	10-19-87	4.19	5.0	4.05

*Mean includes results of third counts:

72858	05-08-85	3.63 ± 5.0%
72850	05-08-85	4.00 ± 5.6%
73477	04-22-85	3.95 ± 4.8%
73491	04-25-85	3.49 ± 5.2%
73500	04-25-85	3.50 ± 4.9%
73917	10-12-87	5.58 ± 6.2%

TABLE 10. CONCENTRATION OF $^{239+240}Pu$ (dpm/g x 10^2) IN EML REFERENCE SOIL

Batch #	ID	Count 1 Date	Pu	%s.d.	Count 2 Date	Pu	%s.d.	Mean
1	72884	07-08-83	1.13	19.0	11-11-83	1.26	5.7	1.29*
2	72863	08-09-83	1.16	6.3	--	--	--	1.16
3	72877	08-21-83	1.19	5.9	--	--	--	1.19
4	72871	08-29-83	1.26	6.1	11-10-83	1.15	6.0	1.20
6	72825	09-04-83	1.20	6.6	11-02-83	1.32	6.3	1.25*
	72826	09-04-83	1.24	6.0	11-02-83	1.16	6.3	1.20
2A	72821	10-18-83	3.77	4.5	10-31-83	3.99	4.5	3.87
7	72837	10-24-83	1.26	5.4	11-09-83	1.15	6.0	1.21
	72832	10-29-83	1.38	5.7	11-08-83	1.26	5.5	1.31
9	72807	11-08-83	1.31	7.0	04-02-85	1.37	7.8	1.34
2B	72800	11-24-83	1.24	6.7	--	--	--	1.24
2E	72793	--	1.12	--	--	--	--	1.12
3A	72772	02-01-84	0.986	9.2	--	--	--	0.986
1A	72773	02-03-84	1.31	5.9	--	--	--	1.31
4A	72759	02-17-84	1.21	9.1	--	--	--	1.21
10	72754	02-28-84	1.25	6.1	03-30-85	1.06	6.6	1.15
11	72743	03-11-84	1.40	6.4	03-29-85	1.18	6.5	1.27
13	72708	03-23-84	1.23	6.7	03-25-85	1.08	6.8	1.15
12	72721	03-29-84	1.25	6.9	--	--	--	1.25
14	72734	04-15-84	1.34	6.7	03-31-85	1.17	7.6	1.25
15	72703	04-27-84	1.16	6.3	03-29-85	1.24	6.7	1.19
17	73307	05-18-84	4.07	5.2	06-22-84	4.32	5.2	4.19
19	73329	05-23-84	1.19	6.2	02-10-85	1.08	6.6	1.13
21	73345	06-27-84	1.22	6.7	04-20-85	1.33	7.6	1.26
22	73354	07-02-84	1.29	6.2	02-15-85	1.14	6.7	1.21
23	73363	07-17-84	1.20	6.9	--	--	--	1.20
27	73402	10-13-84	1.40	6.9	04-21-85	1.18	7.3	1.28

*Mean includes results of third counts:
72884 05-08-85 1.36 ± 6.4%
72825 05-07-85 1.24 ± 6.8%

Criterion 14: Flag the results for a sample if the Cs/Pu ratio is greater than 70.

A large ratio suggests an erroneously high value of Cs or low value of Pu, although under certain conditions NTS fallout from a non-plutonium test could have a ratio greater than 70. Six samples were flagged by this criterion:

73540 BA15-bottom	73572 GC19-bottom	73322 GC29-top
72851 MH02-bottom	72841 MH12-bottom	73942 NM05-bottom

Criterion 15: Flag the results for a site if the Cs/Pu ratio increases by more than 50% from the upper increment to the lower.

Twenty sites were flagged by Criterion 15:

AS06	BE32	DZ05	DZ09
FM29	FM33	FM35	FM39
GC19	MH02	MH12	SW06
AQ04	AQ05	AQ06	AQ07
AQ09	FM32	FM34	NM05

TABLE 11. CONCENTRATION OF $^{239+240}Pu$ (dpm/g x 10^4) IN BLANK SOIL

Batch #	ID	Count 1 Date	Count 1 Pu	Count 1 %s.d.	Count 2 Date	Count 2 Pu	Count 2 %s.d.	Mean
2A	72818	10-14-83	1.7	74.0	11-01-83	2.4	34.0	2.19
9	72810	11-08-83	1.4	43.0	04-03-85	-2.02	3004.1	1.40
2B	72801	11-24-83	3.7	42.0	--	--	--	3.70
2E	72788	--	6.0	--	--	--	--	6.00
3A	72770	02-01-84	2.8	56.0	--	--	--	2.80
1A	72769	02-03-84	4.6	30.0	--	--	--	4.60
4A	72779	02-19-84	1.6	83.0	--	--	--	1.60
10	72756	02-28-84	3.7	31.0	03-30-85	-0.09	65.9	-0.08
13	72709	03-23-84	6.6	26.0	03-25-84	3.8	33.0	4.77
12	72722	03-29-84	3.2	65.0	--	--	--	3.20
14	72730	04-13-84	6.6	28.0	03-30-85	-1.12	131.8	1.89
15	72704	04-27-84	4.7	28.0	03-30-85	2.02	38.4	2.71
18	73319	05-10-84	171.0	5.6	06-22-84	193.0	5.7	180.48
16	72692	05-11-84	5.7	30.0	04-06-85	-0.91	132.7	1.29
20	73336	06-16-84	3.6	33.0	02-10-85	-2.76	323.6	3.49
24	73374	08-29-84	3.6	43.2	01-27-85	1.70	77.6	2.50
25	73380	09-07-84	1.5	100.0	01-22-85	2.99	48.6	2.27
26	73399	09-18-84	3.26	54.7	02-11-85	3.42	35.5	3.37
27	73407	10-13-84	-0.4	259.0	04-21-85	-1.02	101.3	-0.71
28	73418	10-20-84	1.6	115.0	02-17-85	0.40	80.6	0.44
29	73428	10-30-84	9.4	25.0	02-17-85	7.69	22.7	8.30
30	73436	10-31-84	3.65	47.5	04-09-85	9.13	22.7	5.91
31	73453	11-04-84	204.0	7.3	04-25-85	199.0	8.0	201.67
32	73457	11-05-84	13.3	24.3	02-11-85	8.36	25.1	9.82
33	73471	01-18-85	4.0	66.9	01-19-85	5.0	50.3	4.53
34	73478	01-23-85	6.5	26.7	01-24-85	4.40	34.9	4.57*
35	73485	01-26-85	58.6	8.6	01-29-85	57.8	8.8	57.47*
36	73497	01-28-85	5.8	37.9	01-30-85	3.2	58.0	4.12*
37	73512	02-27-85	3.29	32.8	03-03-85	-0.029	71.9	0.08
38	73517	03-08-85	21.7	16.4	03-12-85	21.7	15.8	21.70
39	73529	03-27-85	-0.07	74.6	--	--	--	-0.07
40	73538	04-06-85	2.48	38.4	04-09-85	2.36	40.2	2.42
41	73564	--	<6.		--	--	--	--
42	73588	--	2.0	60.0	--	--	--	2.00
43	73613	02-09-86	1.79	40.6	02-24-86	1.05	44.9	1.27
45	73188	01-17-87	-0.40	390.0	02-20-87	2.50	92.0	0.51
46	73199	02-02-87	7.60	24.1	02-20-87	6.40	28.0	6.99
47	73210	02-05-87	6.90	30.8	02-21-87	10.8	22.0	8.63
48	73264	03-13-87	4.12	39.5	03-21-87	0.640	283.0	2.57
51	73903	05-06-87	0.984	120.0	05-08-87	3.67	42.7	1.96
52	73914	05-07-87	6.11	38.2	05-10-87	3.19	50.3	4.13
54	73272	06-03-87	12.2	28.6	06-04-87	15.4	18.7	14.10
56	73286	08-28-87	4.83	33.9	09-01-87	3.88	37.7	4.30
57	73967	09-08-87	2.29	61.4	09-15-87	5.39	31.4	3.56
58	73969	09-14-87	22.3	22.5	09-16-87	34.0	18.3	26.90
59	73987	09-26-87	1.90	70.8	09-28-87	.659	212.0	1.30
60	73895	10-18-87	1.70	72.2	10-19-87	2.38	50.2	2.05

*Mean includes results of third counts:
73478 04-22-85 3.78 ± 31.2%
73485 04-23-85 56.1 ± 8.7%
73497 04-25-85 3.92 ± 4.2%

Many of these sites were flagged only because the activities in the bottom increment were low and the ratio therefore uncertain.

Isotope Mass Spectroscopy

Samples were submitted for IMS in 12 batches. Batch 1 was a trial batch of samples from rejected plutonium batches, and the results of that batch were not used. The other 11 batches contained 375 samples, of which 50 (13%) were QA samples.

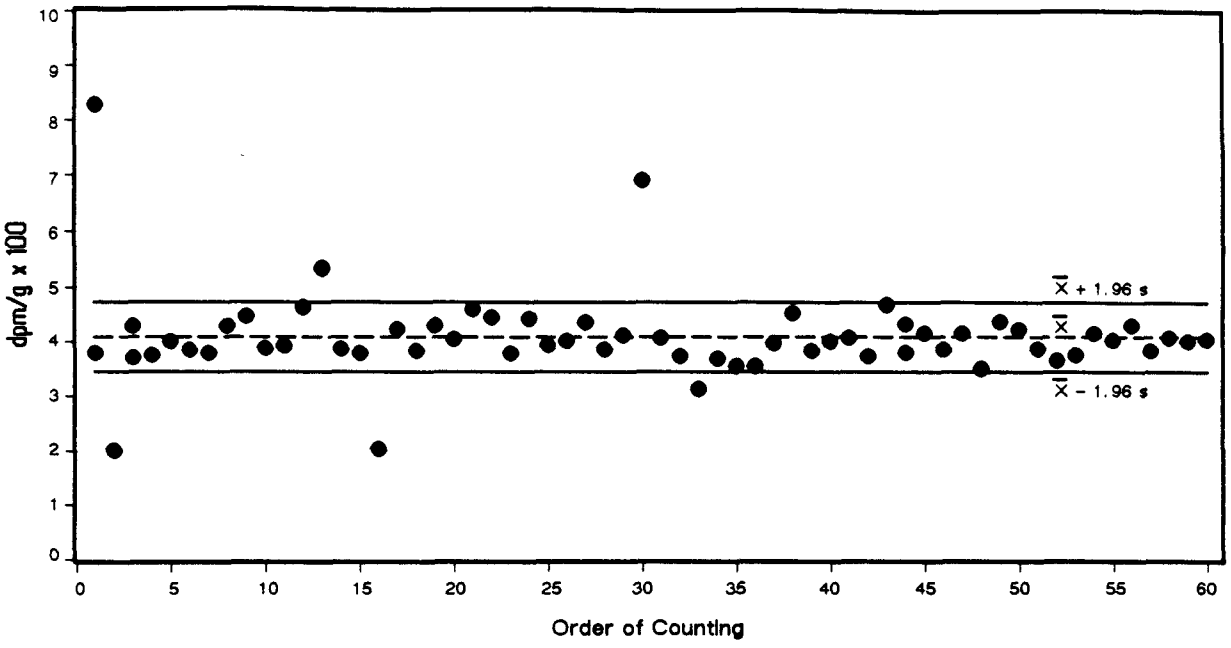

Figure 7. $^{239+240}Pu$ *concentrations in Hurricane soil.*

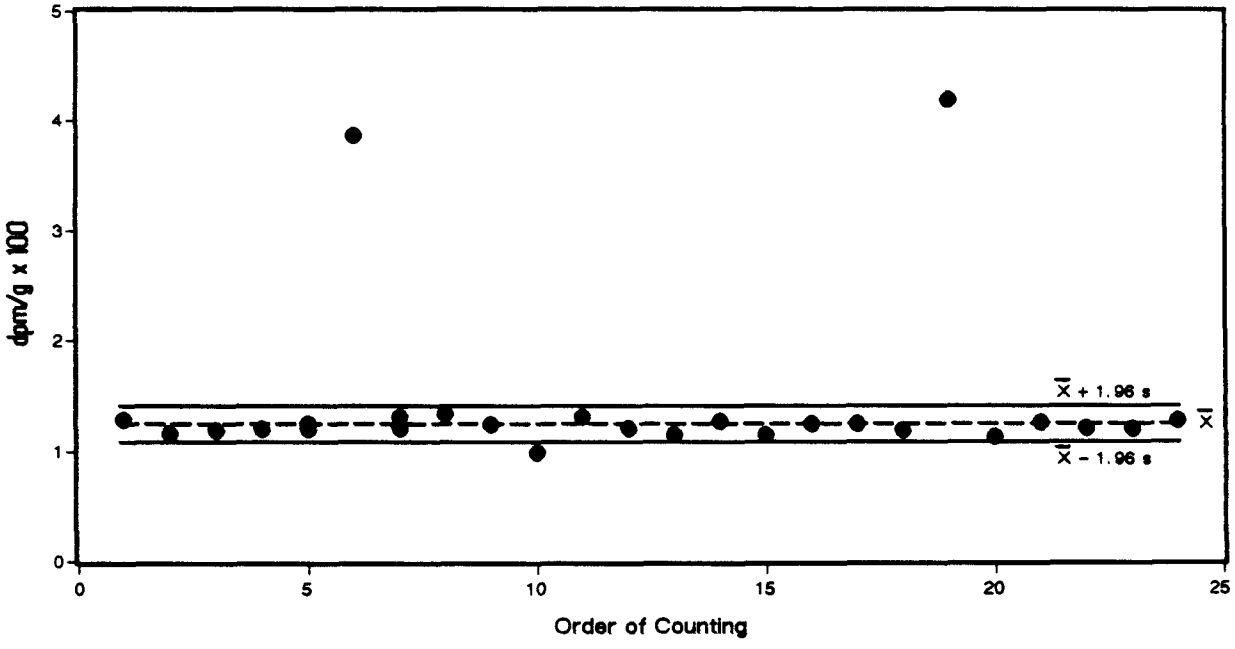

Figure 8. $^{239+240}Pu$ *concentrations in EML reference soil.*

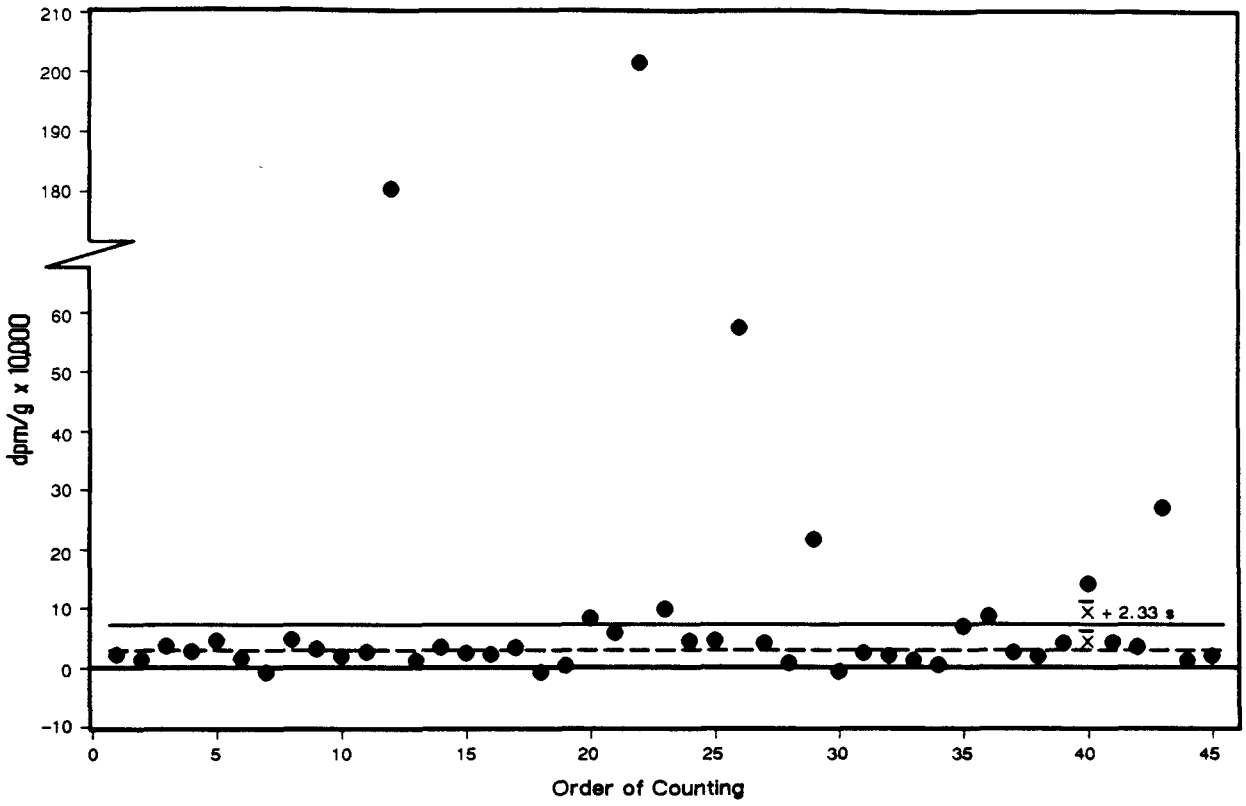

Figure 9. $^{239+240}Pu$ *concentrations in blank soil.*

QA for this phase of the analysis was provided by standard samples. The standards for the early batches were the same reference soils used for the plutonium analyses. Later batches used disks previously electroplated with a standard by EML.

The QA criterion is incorrectly stated in the QA plan. It should read as follows:

Criterion 16: Reanalyze a batch if the $^{240}Pu/^{239}Pu$ ratio in a standard sample differs by more than 5% from the calibrated value.

The data are shown in Table 12. A batch is rejected if D = (observed ratio – calibrated value)/calibrated value is greater than 0.05 for one of the standards. This test was not applied to the PNL standard because the ratio in that standard is too low to be measured so precisely. It was also not applied to the early samples of reference soils (EML–REF, Hurr, and Blank) as there are no "calibrated" values by which to judge the results.

TABLE 12. $^{240}Pu/^{239}Pu$ IN QA SAMPLES

Batch	Sample #	ID	Cal.	Ratio	D
1	72863	EML-REF	--	.1777	--
	72877	EML-REF	--	.1794	--
2	72708	EML-REF	--	.1781	--
3	72721	EML-REF	--	.1766	--
4	72772	EML-REF	--	.1798	--
	72773	EML-REF	--	.1785	--
1	72856	Hurr	--	.1431	--
	72866	Hurr	--	.1038	--
	72876	Hurr	--	.0797	--
4	72760	Hurr	--	.1020	--
5	72763	Hurr	--	.1031	--
2	72709	Blank	--	.1626	--
3	72722	Blank	--	.1646	--
4	72769	Blank	--	.1604	--
	72770	Blank	--	.1663	--
5	72700	EML-1	--	.1303	--
4	--	STD22-4	.00021	.000210	.0
5	73411	PNL #8	.00021	.00054	1.57
	73412	PNL #9	.00021	.00021	.0
	--	STD22-31	.00021	.00020	8.52
6	73603	PNL	.00021	.000240	.143
	73605	PNL	.00021	.0062	28.5
7	73505	PNL	.00021	.000206	.019
	73527	PNL	.00021	.000223	.062
	73542	PNL	.00021	.000524	1.5
8	73514	PNL	.00021	.000205	.024
	73542	PNL	.00021	.00038	.81
	73543	PNL	.00021	.00049	1.33
3	--	STD22-1	.0864	.0861	.003
4	--	STD22-2	.0864	.0864	.0
5	73410	NBL #9	.0864	.0862	.002
	73413	NBL #8	.0864	.0868	.005
6	73601	NBL	.0864	.0870	.007
	73602	NBL	.0864	.0870	.007
	73604	NBL	.0864	.0863	.001
7	73509	NBL	.0864	.0864	.0
	73530	NBL	.0864	.0863	.001
	73543	NBL	.0864	.0858	.007
8	73516	NBL	.0864	.0867	.003
	73521	NBL	.0864	.0861	.003
9	73467	2185	.0863	.0863	.0
	73473	2185	.0863	.0866	.003
	73484	2185	.0863	.0859	.005
	73493	2185	.0863	.0861	.002
	73533	2185	.0863	.0857	.007
10	73292	---	.0864	.0863	.001
	73296	---	.0864	.08589	.006
11	73291	---	.0864	.0864	.0
	73293	---	.0864	.0861	.003
	73294	---	.0864	.0860	.005
	73295	---	.0864	.0860	.005
12	73988	---	.0864	.0863	.001
	73989	---	.0864	.0863	.001
	73990	---	.0864	.0865	.001
	73991	---	.0864	.0865	.001

SUMMARY

The QA criteria described above were not applied to every sample, but this was not because of negligence on the part of the investigators. Most of the samples that were not recounted or realiquoted according to the QA protocols were from sites that had already been rejected for use in the final data set. The next few paragraphs attempt to summarize the quality of the accepted data.

The procedures for gamma-ray spectrometry are relatively straightforward, and few major problems occurred at this stage of the analysis. (The difficulties with the spectral analysis could be considered major in terms of the effort needed to resolve them, but the effect on the final results was minimal.) Of the 1,142 counts of the non-QA samples, only 7 were rejected: the 6 that did not agree with counts of a duplicate aliquot and 1 that did not agree with two subsequent recounts.

In spite of the high reliability of the gamma results, many sites were rejected after this stage. Usually a site was rejected because the Cs results for all four increments did not make sense, suggesting that the site may have been disturbed or that a sample may have been mislabeled. However, the fact that Cs did not decrease with depth did not automatically disqualify a site. Conversely, not all the sites with good Cs profiles were analyzed further, as budgetary considerations usually limited the Pu analyses to one or two sites in each community.

The Pu analysis is more difficult than the gamma-ray analysis, primarily because of the complicated processing required to separate the Pu from the soil. It is not surprising, then, that considerably more effort was required to obtain acceptable Pu results for the 171 sites selected. Numerous platinum disks had to be recounted and numerous samples had to be realiquoted, as summarized in the table below.

	# of counts of sample					
	0	1	2	3	4	
Accepted results	0	20	289	31	6	346
Rejected results	3	43	119	8	0	173
QA samples	1	29	111	11	0	152
	4	92	519	50	6	671

The accepted results include the two increments from each site plus the repeat analyses of FM33 and FM35. Samples that were not counted at all were lost during the preparation.

Almost all of the accepted results passed the various QA tests. Twenty results were accepted on the basis of a single count instead of the specified two (or more) counts. Seven of these were in a batch (#12) for which the first set of counts was thrown out because of problems with the sample preparation. Most of the others were from early batches analyzed before the decision was made to routinely count the samples twice.

In addition, aliquots from increments E35-bottom and KS36-top were prepared and submitted in four different batches, all of which were rejected. However, essentially the same results were obtained for all four aliquots of E35-bottom and for three of the four aliquots of KS36-top, so no further analyses were performed and a representative value was chosen for use in the calculations.

The samples from 14 of the 171 sites were not sent through the final stage of analysis, isotope mass spectroscopy. Most of these were Albuquerque sites that had been rejected because of their Pu results. No problems were encountered with the isotope mass spectroscopy of the remaining samples.

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APPENDIX A

Project Directive No. 4

OFF-SITE RADIATION EXPOSURE REVIEW PROJECT
PROJECT DIRECTIVE NO. 4
DOSE ASSESSMENT IN THE EXTENDED REGION

INTRODUCTION

The first phase of the Off-Site Radiation Exposure Review Project (ORERP) is to establish a mechanism for determining organ doses to individuals who resided within measured fallout patterns during the time of atmospheric nuclear testing.

This directive makes assignments to task groups for Phase II, which is to evaluate the radiation doses to individuals and populations in areas beyond established fallout patterns but within regions where significant quantities of fallout resulting from NTS tests may have been deposited. It also specifies the scaled down activities of the Coordination & Information Center (CIC).

This directive includes two sections. Section I develops general organizational tasks and responsibilities. Section II outlines operational procedures to be followed for completion of Phase II of the project. The Appendixes include supplemental materials as required.

NEVADA OPERATIONS OFFICE (NV)

The NV, through the ORERP Project Manager, has overall responsibility for direction and management of this effort. The Project Manager will approve locations for sampling and analysis in conjunction with the Scientific Director and EML advisors. The Scientific Director will provide overall technical direction of Phase II.

Verbal progress reports will be made weekly (Friday p.m.) to the Assistant Project Managers (Richard Nutley or David Wheeler) by project participants involved in site selection, in situ measurements, and soil collection. Changes in project requirements, budget allocations, and priorities and direction will be made by the Project Manager in consultation with the Scientific Director.

ENVIRONMENTAL MEASUREMENTS LABORATORY (EML)

The EML, as special advisors to the Project Manager, is to assure that Phase II work is consistent with established EML techniques and procedures. They will advise in all major decisions concerning site selection, field spectrometry, soil sampling, soil processing, soil analysis, and apportionment of cesium-137 from global and NTS sources.

EML is requested to design and coordinate with the Desert Research Institute (DRI) an external quality-assurance effort for radionuclide analysis. All data from the project will be available to EML upon request and they will participate in any phase of analysis and reporting that they consider appropriate.

EML will also be responsible for coordinating the analysis of the National Uranium Resource Evaluation (NURE) data with project objectives. EML is requested to obtain and analyze data that are available from their historical networks, which may provide information to identify arrival times of specific events. DRI and the U.S. Weather Service Nuclear Support Office (WSNSO) will assist EML according to EML request.

LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL)

The LLNL will have primary responsibility for making field in situ measurements. These measurements will include field gamma spectrometry and gamma exposure-rate measurements. As these are key measurements that will guide the soil-sample-collection efforts, the LLNL field representative will provide guidance to project personnel concerning the sample-collection effort.

After the samples have been collected and analyzed, LLNL will have the primary responsibility to apportion the cesium-137 to global or NTS sources and to prepare a report or reports for use by other task groups, etc. The DRI and EML will participate in this task as well.

LLNL will also supply the needed source terms for dose reconstruction and will also calculate radiation doses from ingestion after receiving intake values from Colorado State University and will calculate radiation doses from inhalation.

REYNOLDS ELECTRICAL AND ENGINEERING CO., INC. (REECo)

REECo will perform soil collection, sample preparation, and soil analysis for cesium-137; radiochemical separation and measurement of plutonium; and preparation of planchets for mass spectroscopic analysis of plutonium-239 and plutonium-240. Detailed procedures will be approved by EML, the Scientific Director, and NV before soil sampling is started.

The REECo CIC effort will be scaled down for fiscal year 1982 and future years to accommodate this additional effort.

The primary functions will be to support task groups, process documents into the bibliographic data base, keywording, and other archival duties. Specific changes have been made to eliminate abstracting tasks, reduce search and collection tasks, and to support the aforementioned functions at a reduced level of effort.

The collection of soil samples must be done exactly as specified by EML procedures, and must be approved by EML in advance. The same is true of the soil preparation and analytical procedures (i.e., soil drying, crushing, pulverizing, and blending; analysis for cesium-137; and radiochemical separation and measurement of plutonium).

REECo will provide to NV manpower, facility, and equipment needs and update these needs as project direction and priorities change.

DESERT RESEARCH INSTITUTE (DRI)

The DRI will have primary responsibility for the selection of sites that are suitable for potential soil sampling at locations specified by the Project Manager. These sites will be selected according to the criteria used by EML and sufficient interface must exist between DRI and EML to assure that the sites tha are selected actually meet the criteria. Progress of the site-selection process and identification of specific sites will be reported weekly.

DRI will design and manage a data base containing all pertinent descriptive data for each sampling site, soil samples, and laboratory analysis of radionuclide concentrations. DRI will perform data reduction and statistical analysis of data as required for scientific acceptability of the results.

DRI, with assistance from EML, will have primary responsibility for administering an external quality-assurance program governing all phases of soil collection, sample preparation, and sample analysis. DRI will assist REECo in gaining EML's approval of their internal quality-assurance program in advance of beginning analytical work.

LOS ALAMOS NATIONAL LABORATORY (LANL)

The LANL will develop the methodology required to convert the results of the soil-sampling effort into population and individual dose estimates resulting from external exposure including beta dose to skin. This will be done using established procedures and any new lifestyle information that may be developed.

LANL is specifically requested to determine if it would be advisable to develop additional lifestyle information for these calculations in extended areas.

COLORADO STATE UNIVERSITY (CSU)

The CSU will have responsibility for developing values of radionuclide intake by humans in Phase II areas based upon normalized deposition values. They will determine if additional lifestyle and agricultural practices data are needed and will supervise efforts to collect such information.

WEATHER SERVICE NUCLEAR SUPPORT OFFICE (WSNSO)

The WSNSO will assist as directed by the Project Manager in providing meterological information required in Phase II.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The EPA should assist the Phase II effort by searching for environmental data in the extended region and assisting in the interpretaton of such data where they exist.

SECTION II

OPERATIONAL PROCEDURES FOR PHASE II

SITE SELECTION

DRI will select sites suitable for in situ measurements and soil collection, if required, according to the criteria provided by EML as contained in Appendix A. The sites will be selected in locations specified by the Project Manager. Appendix B lists the initial selection of potential sites with maps identifying those locations. The priorities to be used in allocating site-selection teams are first, sites in Northern Arizona; second, sites in Nevada and Utah, north and east of the NTS; third, other sites in Nevada and California; and fourth, sites more distance from the NTS in Oregon, Idaho, Wyoming, Colorado, New Mexico and Arizona.

DRI will be responsible for (1) identifying prospective sites that meet the EML critera; (2) contacting property owners and arranging permission for in situ measurements; (3) determining if soil sampling will be permitted on the site; (4) communicating site location and identification, names of land owners or caretakers, and other relevent information to the LLNL field team; and (5) reporting progress each Friday afternoon.

If good sites are located that are not on the list of selected locations, they should be noted and reported in the weekly progress report.

Multiple sites should be found, if possible, at each populated location with a greater number of sites located in larger communities.

IN SITU SPECTROMETRY

LLNL will make in situ spectrometry and external gamma-exposure-rate mesurements at sites which have been selected by DRI. Field-spectrometry crews will follow site-selection crews as soon as practical to optimize

use of the equipment and time of field workers. Field measurements will be transmitted to the Scientific Director in a timely manner and verbal progress reports will be made to NV each Friday afternoon.

The number and type of measurements to be made at each site will be according to written procedures which are to be provided or referenced to NV by LLNL before field measurements commence.

SOIL COLLECTION

Soil samples will be collected by REECo according to EML procedures contained or referenced in Appendix C at sites to be determined by the Scientific Director and EML. All field crews will be supervised in the field by senior scientific personnel. Soil collection will commence as soon as equipment and personnel have been acquired and trained, and sites have been approved for soil collection.

EML will collect replicate samples at several of the sites and analyze them independently.

SOIL PROCESSING

Soil-sample preparation will be performed by reeco according to procedures outlined or referenced in Appendix D, which have been approved by the Scientific Director and EML. As cross contamination of samples would be very serious, measures must be taken to prevent this. DRI will be responsible for determining which samples will be sent to EML as part of the Quality-Assurance Program that will monitor the soil-processing program.

SOIL-SAMPLE ANALYSIS AND CHEMICAL SEPARATION

Sample spectroscopic analysis and chemical separation will be performed by REECo according to procedures contained or referenced in Appendix E. Samples will first be analyzed by gamma spectroscopy to determine the

concentrations of all gamma-emitting radionuclides including those that occur naturally.

The spectroscopic results will be analyzed by EML, DRI, and the Scientific Director to determine which samples will be selected for radiochemical analysis of plutonium. Chemical separation will include the deposition of plutonium on planchets which can be used for analysis for plutonium-239 and -240 by mass spectroscopy. EML will recommend a contractor to perform mass-spectroscopy analysis of plutonium isotopes and will supervise the quality assurance of that program.

QUALITY-ASSURANCE PROGRAM (QA)

DRI, with the assistance of EML, will develop an external quality-assurance program, will be included as Appendix F of this directive. They will jointly administer the program and make recommendations to NV as required. DRI and EML will assist REECo in reviewing their internal QA program. DRI will report to NV, on a regular basis, the progress of sample analysis and any problems that have been identified by the QA program.

PROJECT MANAGEMENT

The program which has been outlined in Phase II of ORERP will be administed by NV under the direction of Bruce W. Church, Project Manager. Lynn Anspaugh, Scientific Director, has primary responsibility for selecting sites suitable for soil sampling. Howard Hawthorne, *Senior Scientist, has primary responsiblity for soil collection, sample preparation, and sample analysis. Forest Miller, DRI, has primary responsiblity for quality assurance. Lynn Anspaugh, LLNL, is reponsible for final determinatoin of cesium-137 distribution resulting from NTS testing. Bruce Church, Lynn Anspaugh, Harold Beck or Phil Krey, Howard Hawthorne and Forest Miller will meet approximately monthly or as needed

*Note: Howard Hawthorne left the project in December 1982. Stephen Rohrer, Senior Scientist, functions in this capacity.

to review progress of the project and to make administrative decisions concerning continuation of the project. Reports will be prepared by REECo on the soil collection and analysis and by LLNL, DRI, and EML on the total evaluation of cesium-137 resulting from NTS testing in regions covered by Phase II.

Lynn R. Anspaugh
Scientific Director

Bruce W. Church
Project Manager

APPENDIX A

PROJECT DIRECTIVE NO. 4
EML SITE CRITERIA FOR RADIATION MEASUREMENTS AND SOIL SAMPLING

The soil-sampling program incorporated in Project Directive No. 4 depends upon the assurance that a representative sample of the cesium and plutonium that were deposited with the fallout during the atmospheric testing program at the Nevada Test Site can be collected by the procedures outlined herein. EML has ascertained that undisturbed grassy areas that meet the following criteria will satisfy this requirement. These criteria are therefore to be followed in selecting suitable sites for soil collection.

A. General:

1. Relatively flat open area, at least 40 feet in diameter, away from man-made structures, ditches, and roadways, and any natural obstructions;

2. Minimal rock outcropping or debris;

3. Site should be similar in nature to surrounding land and at the same elevation, that is, not raised or depressed compared to the general grade of the land;

4. Ground should not be sloped to a degree such that runoff or water erosion might have occurred.

B. Undisturbed Since 1950:

1. No plowing, tilling or overturning of the soil;

2. No grading;

3. Minimal burrowing activity from rodents, moles, groundhogs, lizards, etc.;

4. No removal or addition of topsoil;

5. No flash flooding.

C. Ground Cover Present:

1. Site must have possessed some type of ground cover, such as grass, since 1950 so that minimal wind or water erosion occurred;

2. However, the site should not have been subjected to blowsand buildup from wind or silt buildup from irrigation.

D. Allowable Activities:

Watering (including flood irrigation), mowing, cutting, weeding, fertilizing, seeding.

E. Examples of Ideal Sites:

1. Old lawns in parks, church yards, cemeteries or private residences;

2. Pastures with reasonably dense vegetation.

ADDENDUM TO EML SITE SELECTION CRITERIA

1. Attempt to disperse prospective sites throughout a population center as opposed to concentrating sites in only a few areas.

2. Attempt to prioritize site selection so as to find "best" sites first, e.g., large lawns, parks, cemeteries, etc., as opposed to small lawns or other marginal sites. We suggest trying to obtain old maps which might identify schools, parks, and buildings which existed in 1950 - 1960.

3. When selecting sites, look for signs of disturbance such as new sprinkler systems, young trees, etc. Try to obtain corroboratory testimony of site age from more than one person if possible, particularly if site appears suspicious.

4. Avoid depressions where water may accumulate or pool from run off.

5. When documenting candidate sites, be very specific as to exact location, i.e., which part of which lawn (front or back, etc.). Draw detailed map. Write down names of sources and name of person giving permission to sample.

6. Sites less than 40 feet in diameter can be selected if no alternatives are available and they meet all other criteria. Adjustments will, of course, have to be made in interpretation of the field-gamma spectral analysis. This can be done provided the areas outside the site boundary do not consist of depressions or silt buildup, which may contain enhanced levels of cesium-137 that would distort the in situ spectral measurement.

Revised: 1/31/85

SUGGESTED IN SITU SPECTRAL ANALYSIS PROCEDURES

1. Count long enough to obtain better than ± 5% (1 σ) precision for cesium-137 (if practical).

2. Watch for unusual natural emitter activities suggesting site is not typical of surrounding terrain.

3. Examine agreement between sum of individual exposure rates inferred from spectrometer and total from the high pressure ion chamber. Poor agreement may suggest a non-uniform natural emitter depth profile and thus a possibly disturbed site.

4. For very large areas such as parks, cemeteries, etc., where several choices of exact measurement sites are available, it would be advisable to make subsidiary low-precision counts at 1 - 2 positions other than that chosen from the prime measurement in order to confirm the prime site is representative of the entire area.

5. For sites less than 40 feet in diameter, draw map and indicate exact dimensions of site and position of detector.

6. The in situ flux depends on the soil moisture at the time of measurement as well as the depth profile of the activity in the soil. Since the spectra will be taken days or weeks prior to soil sampling, it will be necessary to at least estimate the moisture content at the time of the spectral measurement (i.e., ground just watered, very moist and spongy to very dry and hard). It would be preferrable if the field-spectrometer team could take several handfulls of surface soil (0-2 cm) from each site, weigh it on the spot, and then store it for subsequent drying and re-weighing. If weighing in the field is impractical, the soil should be sealed in water-tight plastic bags. Some estimate of the soil moisture will be required in order to compare results at various sites and in order to compare the in situ results with the soil analyses.

Revised: 3/27/85

APPENDIX B

PROJECT DIRECTIVE NO. 4
PROPOSED SITES FOR SOIL SAMPLING
AND THEIR UTM COORDINATES

NEVADA (51)

*Alamo	11SPM6336	*Indian Springs	11SPL2048
Austin	11SMP9471	Lage's Station	
Babbitt	11SLN5766	Las Vegas	11SPL6704
Baker	11SQP4922	*Logandale	11SQL2553
Battle Mountain	11SNQ0599	Lovelock	11TLQ7448
*Beatty	11SNL2184	Major's Place	11SQP0921
Belmont	11SNN1171	McGill	11SPP9163
Boulder City	11SPK9683	*Mesquite	11SQL6177
*Bunkerville	11SQL5673	Minden	11SKP6015
*Caliente	11SQM1965	North Las Vegas	11SPL7008
Carlin	11TNR7507	*Overton	11SQL2847
Carson City	11SKP6139	*Pioche	11SQN2402
*Currant	11SPN3389	Pahrump	11SNL9107
*Duckwater	11SPP1506	Reno	11SKP5980
East Ely	11SPP8446	Round Mountain	11SMN9484
Elko	11TPR0421	Ruth	11SPP7449
Ely	11SPP8246	*Searchlight	11SPK8926
Empire	11SKP6640	Sparks	11SKP6380
Eureka	11SNP8974	*Sunnyside	11SPN7354
Fallon	11SLP4770	*Tonopah	11SMN8013
Gabbs	11SMP2120	*Warm Springs	11SNN5527
Gardnerville	11SKP6214	Wells	11TPR7153
*Goldfield	11SMM8073	Winnemucca	11TMR3835
Hawthorne	11SLN5865	Yerington	11SLP1317
Henderson	11SPK8289		
*Hiko	11SPM5762		

CALIFORNIA (8)

Baker	11SNK8402	Death Valley	11SNL1333
Barstow	11SMJ9860	(Furnance Creek)	
Big Pine	11SLM8614	Lone Pine	11SNL0451
Bishop	11SLM7635	Tom's Place	11SLM5258
China Lake	11SMK4145		11SLM5258

ARIZONA (12)

Colorado City	12SUR2495	Littlefield	12STR4086
Flagstaff	12SVP4195	Mt. Trumbull	12STR9231
Fredonia	12SUR6489	Peach Springs	12STQ8134
Grand Canyon	12SUQ9790	Seligman	12SUQ2910
Holbrook	12SWP7663	Williams	12SUQ9201
Kingman	11SQJ6898		

*For Correlation with Fallout Pattern Estimates

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UTAH (63)

**American Fork	12TVV3270	**Milford	12SUT2451
**Beaver	12SUT5637	**Minersville	12SUT3231
**Blanding	12SXS3465	**Moab	12SXT2671
**Bountiful	12TVA2626	**Modena	12STS4387
**Brigham City	12TVA1596	**Monticello	12SXS4693
Callao	12STV6920	**Mt. Carmel	12SUS5223
**Cedar City	12SUS1871	**Murray	12TVA2502
**Clearfield	12TVA1551	**Nephi	12SVU2996
**Delta	12SUU4657	**Ogden	12TVA1963
**Dragerton		**Panquitch	12SUS7387
**Duchesne	12TWV5145	**Paragonah	12SUS4494
**Enterprise	12STS6062	Park Valley	
**Fillmore	12SUU8414	**Parowan	12SUS3990
Garrison	11SQP5613	**Payson	12TVV3733
**Green River	12SWU7316	**Price	12SWU1683
**Gunnison	12SVU2934	**Provo	12TVV4555
**Hanksville		**Richfield	12SVT0591
**Hatch	12SUS7368	**Salem	12TVV4334
**Heber City	12TVV6584	**Salt Lake City	12TVA2510
**Hurricane	12STS9716	**Santa Clara	12STS6412
Ibapah		**Spanish Fork	12TVV4540
Iosepa		**Springville	12TVV4846
**Kanab	12SUS6401	**St. George	12STS7110
**Kanarraville	12SUS0756	**Sunnyside	12SWU5278
**La Verkin	12STS9819	**Tooele	12TUV9087
**Layton	12TVA1946	**Tremonton	12TVB0318
**Logan	12TVB3121	**Vernal	12TXA2597
**Magna	12TVA0706	**Veyo	12STS6235
**Manti	12SVU7546	**Washington	12STS7712
**Midvale	12TVV2495	Wendover	11TQR5013

IDAHO (6)

Boise	Malad City
Burley	Pocatello
Idaho Falls	Twin Falls

OREGON (2)

Burns
Jordan Valley

**Stations previously sampled by EML. Will not be resampled.

Revised: 1/31/85

NEW MEXICO (3)

Albuquerque
Farmington
Gallup

WYOMING (6)

Afton
Evanston
Kemmerer
Rawlins
Riverton
Rock Springs

COLORADO (9)

Cortez
Craig
Durango
**Grand Junction
Meeker
Montrose
Rangely
Rifle
Telluride

**Stations previously sampled by EML. Will not be resampled.

Revised: 1/31/85

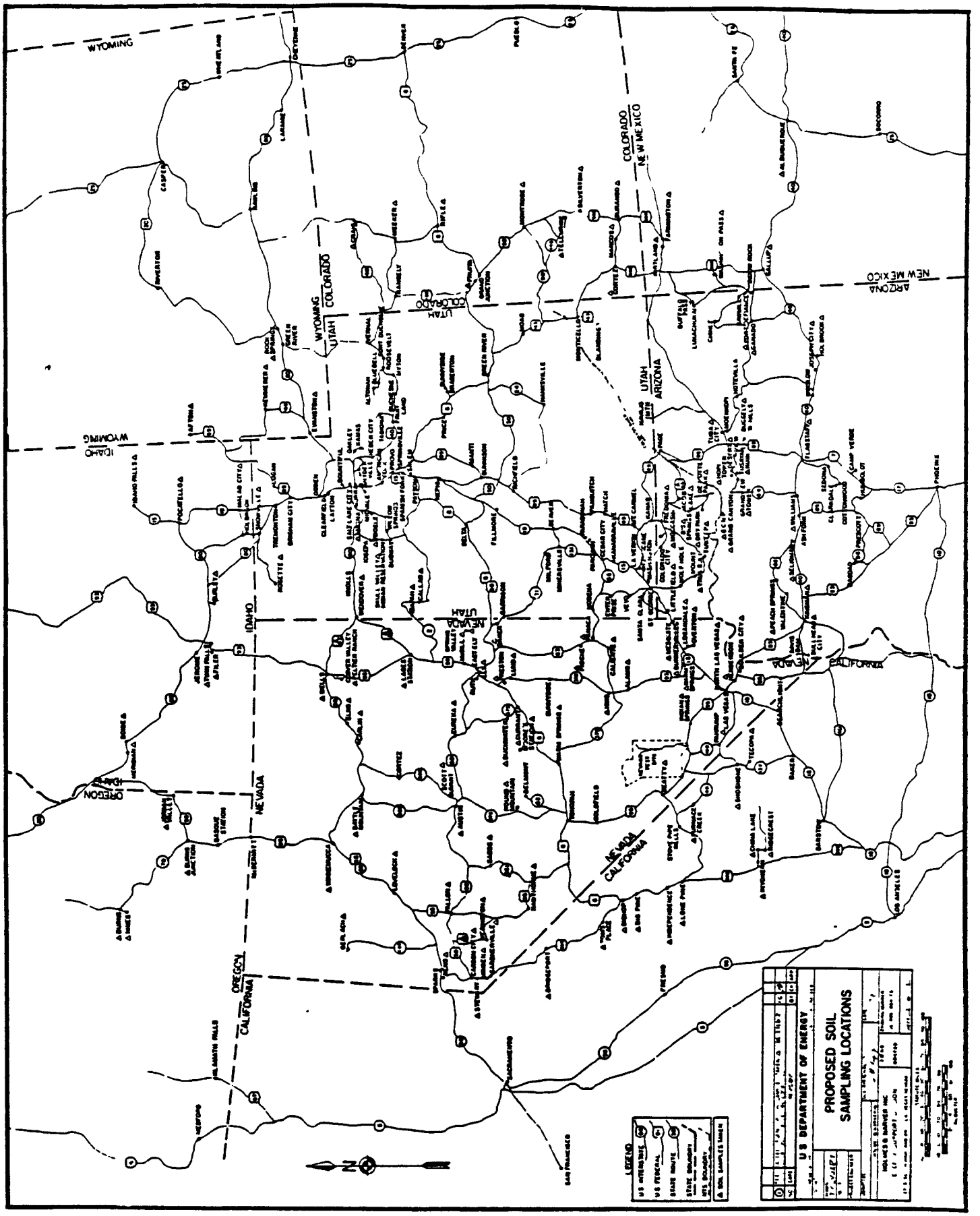

Figure B1. Proposed Soil Sampling Locations

APPENDIX C

PROJECT DIRECTIVE NO. 4
SOIL-SAMPLE-COLLECTION PROCEDURES

The purpose of the soil collection is to provide representative samples that can be used to measure the total or areal concentration of cesium-137 and plutonium-239+240 and the ratio of plutonium-240 to plutonium-239. These data can then be used to resolve the source of the radionuclides found at selected sampling sites. The sites are selected beforehand and permission to collect the soil samples arranged in advance of collection teams coming to the sites chosen. Clear directions for locating the sampling stations are provided by the in situ field crews.

Soil samples are obtained using a coring procedure that maintains the integrity of the core. The sides of the excavation must not be allowed to crumble into the hole, or cave in, or to slump or otherwise contaminate the core sample with extra soil or radioactivty. The greatest hazard in the procedure is contaminating subsurface soil with radioactivity from overlaying layers or from the surface layer itself.

The grassy-site soil-collecting procedure developed by the Environmental Measurements Laboratory (EML) has been mandated as the methodology to be followed. A total of 10 cores is to be collected from each sampling site. Each core is to be collected in four increments. In grass lawns that are heavily watered, the depth increments are to be 0 to 5, 5 to 10, 10 to 15 and 15 to 30 centimeters. In native pastures, the increments are to be 0 to 2.5, 2.5 to 5, 5 to 10, and 10 to 30 centimeters. Four packages of increments from 10 separate cores of soil are to leave each sample site. The labels on each package are to be identical with respect to soil-station identification, the only difference being in the depth increment on the label. A duplicate label is to be written, enclosed in a sealed plastic zip-lock baggie, and placed in each package before it is sealed.

Collection of Soil Cores

Core cutters are to be used at grassy stations. A topsoil cutter (8.9 centimeters in diameter) is used to remove a plug of sod and roots from the 0 to 5 centimeter increment in both lawns and pastures. In lawns the 0 to 5 centimeter sample is packaged. The plug is to be extruded from the cutter in pastures so the 2.5 to 5 centimeter increment can be cut off. The remaining 0 to 2.5 centimeter increment is packaged in pastures as an independent depth increment. The mid-length core cutter (8.9 centimeters in diameter) is to be used for taking the 5 to 10 centimeter increment, and the longest core cutter removes the 10 to 15 centimeter specimen. Insertion of the longer core cutters through the surface into the hole created by extraction of the first increment is the most critical step in the entire process. Dislodging any of the contaminated surface layer ruins the core for radionuclide estimation, and requires abandonment of the core and extraction of a new 0 to 5 centimeter increment at a different station-coordinate location. Fortunately the walls of the holes are compressed slightly when the corer is removed, so that the next longer corer generally slips down the hole without much friction or difficulty.

After removal of the 0 to 5, 5 to 10, and 10 to 15 centimeter increments, an 8.3 cm diameter barrel-type soil auger with an 9.4 centimeter maximum diameter cutting edge is inserted into the hole to take the 15 to 30 centimeter increment for lawns or the 10 to 30 centimeter increment for pastures. Wall compression also allows insertion of this slightly larger diameter auger into the hole without dislodging any significant amount of soil. Some augers available from or used by EML had slightly smaller cutting diameters of 8.9 cm or 9.1 cm. The appropriate areas for the different samplers and depth increments should be used in estimating the aerial concentration of the radionuclides. At the conclusion of the collection, there will be four separate composite packages of soil from 10 cores, one per depth increment.

Upon arrival at soil sites where soil cores are to be collected, the soil-collection team follows the directions to locate the sampling area and the in situ location is "walked over." The selected site should be representative of the total area and free of depressions where pooling of

water could occur. An area 2 by 5 meters for the soil-core specimens is chosen. A line, 5 meters long, is laid out along which measurements are to be made to locate core specimens. Spacing of the potential core locations is to be at 45 centimeter invervals along the line.

A total of 10 cores must be collected to obtain the specified minimum area of 620 square centimeters. All ten core specimens, for a given depth increment, are composited into one package, making four packages per collection site.

Circumstances may require that more than ten cores be selected and sampled to bring back 10 incremental composite core samples. Large underground rocks, tree roots, caliche and other conditions may cancel completion of a 30-centimeter-deep core extraction and require that a replacement core be chosen and extracted. When a hole is abandoned, all increments are to be returned to the hole in reverse collection order, to restore the core to its natural sequence, and the sod plug is to be replaced. The weight of ten cores of soil, all four packages together, should be in the range of 18 to 40 kilograms.

Soil is collected by pressing the topsoil cutter into the ground without tilting or rotating the cutter. In dense turf it may be advisable to drive the cutter by placing a 2" x 4" through the handle and driving the cutter down with a rubber mallet. The handle of the topsoil cutter is gently twisted to loosen the core, then the core cutter and soil increment are removed from the hole. The next longer length cutter is immediately inserted in the hole to reduce drying and crumbling of the soil while the increment from the higher increment cutter is being processed. The mid-length cutter for the 5 to 10 centimeter increment is utilized as described for the topsoil cutter. After the mid-length cutter is removed from the hole the long cutter is inserted to reduce evaporation and soil crumbs. The auger is placed in the hole when the last cutter is removed. Only slight downward pressure is needed on the soil auger because the cutting tips are sharpened, and they cut as the auger turns. The auger is then filled with soil, removed, and emptied. This is repeated carefully if needed. A dull, flat blade knife is useful in cleaning the auger of clay soil. When rocks or roots catch in the auger tips they may be cut through with patience, if they cannot be captured inside the auger, then the

hole is to be cleared with hammer and chisel or a new core selection made for another core. It is helpful to have a small plastic bucket for each core increment to be kept in until the success in extracting a complete soil core is known. No more than one core increment should be added to each of the buckets before they are transfered into the package for the 10-core composite increment at that collection station.

When the ten core specimens for a station depth increment are packaged, and an inside label enclosed with the increment, the end of the bag is folded over and stapled, the stapled fold is taped, and the site identification is written on the tape so the bags can be identified when they are stacked in storage. The plastic bags are placed in canvas bags for transportation to the processing station.

Holes are to be filled with soil and tamped to prevent accidents. When possible, soil as much like that removed is to be used. If a new grass cover is required at once, plugs from local sod around the edge of the site of the same species are to be taken and transplanted into the holes. In normal sod the grass will cover the bare spots in a few weeks.

Sampling Equipment for the Core Method

Top Soil Cutters - Nominal 2", 4", and 6" depth, 8.9 centimeter diameter. Made from 0.062" thick cold-rolled steel. One end sharpened in a lathe, the other end fitted with a welded D-handle.

Auger - Special order type No. R-HEO, 8.3 centimeter diameter, with T-handle and barrel closed to 12". The maximum diameter of the cutting edge should be 8.9 cm. (This measurement must be known for calculations of areal deposition.)

Vendor: Art's Machine Shop
American Falls, Idaho 83211

The following auxiliary materials are normally used in the field:

Polaroid camera with film packs
35mm camera with film
Heavy plastic bags for sample packages
Canvas bags for shipping samples
Tags for sample identification and shipping
Felt marking pens
18" rule
Heavy duty stapler and 1/2" staples
Long, flat blade knife for removing cores from auger
Measuring tape (50 ft.) cloth
Compass
File for smoothing nicks in top soil cutters
Rubber mallet
Plastic bucket (5 qt.) for each depth increment, in different colors
Small spatula
16" long cold chisels
Short handled, 2 lb. steel sledge hammer
Cardboard labels for increments
Plastic "baggies" for cardboard labels
Safety glasses to wear when using the steel hammer and chisel

APPENDIX D

PROJECT DIRECTIVE NO. 4
SOIL-SAMPLE-PREPARATION PROCEDURE

The objective in soil-sample processing is the preparation of an increment sample into subsamples for gamma and plutonium analysis. These subsamples should be representative of the site and the soil depth level from which the increment sample was taken and not contaminated by material from another depth level within that site or by material from another site. Close attention must be paid to each step in this procedure to eliminate the possibility of cross-contamination. The three main sources of cross-contamination are

- Transfer by handling within the preparation laboratory
- Transfer by tools, equipment, or materials
- Transfer by airborne particles

The same procedures are followed for the preparation of both ORERP soils and quality-control soils.

A. Soil-Sample Identification

To assure that the soil samples are prepared and analyzed in a "blind" manner, the Desert Research Institute (DRI) randomly assigns each increment sample a sample-identification number taken from a serial list that is compatible with those used by the counting laboratory. These 5-digit sample numbers are used to identify each increment sample throughout the soil preparation and analysis operations. Quality-control samples are identified in a similar manner.

The following steps are followed by DRI when assigning the soil ID numbers.

NOTE: DRI is responsible for maintaining all records associated with soil-sample identification.

1. Select soil from 5-7 collection sites at a time. Remove the increment samples (4 per collection site) from the cloth field-collection bags.

2. For each increment sample, record the original site-identification number, the depth level, and a randomly assigned soil-ID number.

3. Cross out or remove the original site-identification number from the sample bag. Write the new soil-ID number on the sample bag.

4. Repeat steps A.2 and A.3 for all the increment samples. Place the sample bags on shelves until needed for soil processing.

5. After 10-20 plutonium subsamples have been prepared, replace the temporarily assigned numbers (see section C) with randomized numbers.

B. Soil-Sample Processing

The following are the steps for the initial processing of soil samples for the gamma and plutonium analyses.

NOTE: Surgical gloves shall be worn while handling the soil through the following steps.

1. Bring a sample bag into the soil-preparation area. Record the soil-ID number and the date on the Soil-Prep Worksheet (columns 1 and 2).

NOTE: All weights called for in this section shall be recorded in grams on the Soil-Prep Worksheet (see Figure D1).

2. For each sample bag, wipe the outside with a Kimwipe and discard the wipe. Knead the soil while it is still in the sealed bag so that any moisture condensed on the inside surface of the bag will be reabsorbed by the soil. Weigh the bag of soil and record the weight in grams in column 3 of the worksheet.

3. Place the sample bag upside down in a 24- x 36-inch plastic transfer bag and cut off the bottom seam of the sample bag. (Save the seam for weighing later [see step B.8].)

4. Weigh an empty one-gallon can and, using a flow pen, mark this weight (tare weight) on the can along with the soil-ID number. Record the weight (worksheet column 6).

5. Empty the sample bag into the transfer bag and keep the empty sample bag for later. Any roots or rocks larger than approximately one inch in diameter should be thoroughly wire brushed, set aside, and saved. Break apart any clumps of grass and root mats and cut up the pieces into lengths of not more than 0.25 inches.

6. Working inside the transfer bag, use a scoop to transfer sufficient sample to fill the can approximately one-third full. Repeat step B.4 and fill additional tared cans until all the sample has been canned. Use a new line on the worksheet for each can of soil. (Take care to brush off any adhering dirt from the outside, bottom, and rim of the can before removing the can from the transfer bag.)

   NOTE: Any soil falling <u>outside</u> of the transfer bag is to be discarded rather than risk cross-contaminating the sample by picking the soil up from the table or floor and adding the soil back to the sample.

7. Weigh each can, record the weight (worksheet column 7) and place the uncovered cans in a drying oven for at least 24 hours at 105°C.

8. Weigh the empty sample bag (including any pieces cut off the bottom), field-ID tags, tape, and discarded roots and rocks, and record the weight (worksheet column 4). (Save these materials. They will be sent to the Nevada Test Site for storage.)

NOTE: At this time a new sample bag may be processed. Make sure that any tools used are scrupulously cleaned and a new transfer bag is used for each new sample bag. Continue processing sample bags until the drying ovens are full.

9. After 24 hours (minimum), remove each sample can from the oven, reweigh the can to obtain the sample dry weight and record (worksheet columns 9 and 10).

NOTE: If a sample is contained in more than one can, the weights of the individual cans should be totaled and recorded on one line of the worksheet. From this point in the procedure, all data for each sample ID number should be recorded on this "total" line.

10. Add 10 grinding balls to each can and put a lid and clips on each can. At this time make sure that the sample-ID number and the time are put on the lid with a flow pen since this information is frequently worn off the sides of the cans while in the ball mill. Place each can in the ball mill for three hours at 130 to 140 rpm.

11. Before beginning the sieving operation to obtain the less than 500-micrometer fraction, line the hood with an opened 24- x 36-inch plastic bag and lay out clean tools in a large aluminum pan. (This step organizes the procedure and allows any spills to be caught.)

NOTE: All sieving and subsequent soil-transfer operations shall be performed in the hood. The sieving will be done in three stages, but the first stage is the most difficult since it deals with the largest volume of sample.

12. Tare two new cans and record the tare weight and the soil-ID number on the cans. (One can will be used to collect and store the fine fraction and the other will be used to collect the coarse fraction for the second ball milling.) Invert the sample can and completely remove the bottom with a can opener.

13. Tape the collection pan to the bottom of the sieve. Place the sieve-collection-pan unit upside down over the sample can. Quickly invert the can and empty the soil onto the sieve. Tape a lid to the sieve and agitate the entire sieve unit (collection pan, sieve, lid) on the shaker to separate the fine fraction (collected in bottom pan) from the coarse fraction.

14. After sieving, use tongs to remove the 10 grinding balls and temporarily store the balls in a small aluminum pan. If there is more than one can per soil sample, the 10 balls from the second can shall be added to the 10 balls from the first can. (In the event there are more than two original sample cans, discard anything over 20 balls.)

15. Transfer the fine and coarse fractions into their respective cans using funnels. Use additional tared cans for the fine fraction if necessary.

16. Once all cans from any one soil sample have been sieved and the coarse fractions from each have all been collected in the one tared can, weigh the coarse fraction and record (worksheet column 13). Add all the grinding balls, cover, clip and run the can in the ball mill for one hour.

17. Sieve, separate, weigh and record (worksheet column 14) as before. Remember to remove all the balls. Use these same balls over again for the third and last ball milling. Write the time, sample-ID number, and number of cans on the lid when returning the sample to the ball mill for the second or third run.

18. After the third ball milling, sieving, and separating, collect the coarse fraction (if any) in a tared Nalgene bottle; weigh and record (worksheet column 15). Discard the grinding balls; stir the fine material with a spatula; weigh and record (worksheet column 16). Firmly put a lid on the can and place the can in the ball mill for a few minutes to homogenize. Wash all hand tools used in the ball

milling and sieving operations in the sonic cleaner. Rinse and oven-dry the tools.

C. Preparation of Subsamples for Gamma and Plutonium Analysis

At this point of the soil-preparation procedure, the fine fraction from each sample is contained in one or more one-gallon cans. The fine fraction from each of the smaller samples can usually be contained in one can, but soil from the larger samples may require from 3 to 6 or more cans. This fine soil fraction is used to make up the subsamples for gamma and plutonium analysis.

Each subsample for gamma analysis contains 500 milliliters (approximately 700 grams) of soil from one sample. Each subsample for plutonium analysis is a composite of two samples and consists of 200.0 grams of soil.

The following steps shall be followed when preparing the gamma and plutonium subsamples for analysis. All soil transferring shall be performed in a hood.

NOTE: In the case of a multiple-can sample, the total quantity of soil to be removed from that particular increment sample must be divided by the number of cans comprising that sample in order to get equal amounts of soil from each can. In this way soil from all cans of a multiple-can sample is used to make the 500-milliliter gamma and 200-gram plutonium subsamples.

Gamma-Analysis Subsamples

1. For each sample, make up two subsamples (A and B) in 500-milliliter Nalgene bottles from the fine fraction. Use the vibrating spatula to pack the soil in the bottles. If sufficient soil is not available for two 500-milliliter subsamples (approximately 700 grams each), make just one subsample (A). Label each bottle with the soil-ID number and an "A" or "B" as appropriate.

2. Store subsample A until notified by DRI to send a set of subsamples to Laboratory Operations for gamma analysis. Place subsample B in separate storage at the soil-preparation lab. Hold the rest of the fine fraction in inventory until further processing is required.

3. Upon notification by DRI, prepare a set of 700-gram subsamples including any quality-control samples identified by DRI. Send the subsample set to Laboratory Operations and record the date (worksheet column 19). A completed Laboratory Services Request (RE-1585) shall accompany each set of subsamples.

Plutonium-Analysis Subsamples

NOTE: DRI will send instructions to the Soil-Preparation Lab for preparing the plutonium subsamples. The composite subsamples will be assigned a temporary preparation number. These preparation numbers are temporarily assigned to the samples to trace them through the soil-preparation lab only. Permanent ID numbers are later assigned to these samples and to other samples included as quality controls. An example of the DRI instructions follows:

> Please prepare the 200-gram subsamples defined below. Use the formula:
>
> Add A grams of sample B to C grams of sample D and label the composite with the temporary preparation number E.

A	B	C	D	E
47.4	72027	152.6	72008	A1
35.8	72148	164.2	72154	A2
38.1	72045	161.9	72038	A3

4. Upon receipt of the plutonium-subsample instructions, take the appropriate cans from the shelves and group the cans forming each subsample together. Write the temporary preparation number on the

lid of each of these cans. Repeat this step for all samples listed on the instructions.

5. Since many of the increment samples are contained in multiple cans, calculate the quantity of soil to be removed from each can of a multiple-can sample and write the results on the instruction sheet. Do this for all samples listed. Since this sheet will be referred to repeatedly during subsample preparation, place the sheet in the soil-preparation area.

6. Carry each subsample group of cans into the soil-preparation area and place the cans on the ball mill. Roll the cans for 4 minutes, remove the cans, and invert them several times to thoroughly mix the soil.

   NOTE: Beginning 10/31/83, a daily log will be kept of all sample cans carried into the soil-preparation area. This will provide a verifiable checklist of samples entering the soil-preparation area.

7. Before proceeding, check the temporary ID number on the cans with the same number on the instruction sheet. Then check the 5-digit sample number on the cans with the number on the sheet. (This ensures that the aliquot taken is from the correct increment sample.)

8. Place a 175-milliliter Nalgene bottle onto the continuous read-out digital scale and tare to 0.0 grams. Open the first can and recheck the sample number. Remove soil from the can with a vibrating spatula, and place the required aliquot of soil into the tared bottle. Check the weight with that listed on the instruction sheet.

9. Vacuum the can lid and rim and the spatula to remove any soil. Replace the lid onto the can. Before proceeding to another can, double-check the 5-digit sample number on the first can with the number listed in the instructions.

10. Retare the subsample bottle, which now contains the first aliquot of soil, back to 0.0 grams.

11. Open the next can needed for the plutonium subsample. Once again, compare the 5-digit sample number on the can with the number on the instruction sheet. Scoop the required amount of soil from the can into the retared bottle. If soil is being removed from more than one can (as in a multiple-can sample), retare the bottle and contents after each soil aliquot is added. Remember to perform step C.9 for all cans.

    NOTE: If too much soil is added to the bottle during this step, discard the entire bottle and begin again at step C.8.

12. Screw the cap onto the plutonium-subsample bottle and reweigh to ensure that a complete 200-gram subsample has been achieved.

13. Label the bottle with the temporary ID number indicated on the instruction sheet and place the bottle on a storage shelf. Do this step for all bottles upon completion of the subsample preparation.

14. When DRI assigns a permanent 5-digit sample number to each subsample bottle, remove the temporary ID number and replace with the permanent sample-ID number. DRI shall introduce identical bottles of quality-control soil at this time.

15. After the subsamples have been renumbered, send a set of bottles to Laboratory Operations. Quality-control soil shall be included in each set of 200-gram subsamples. A completed Laboratory Services Request (RE-1585) shall accompany each set of bottles.

16. After the plutonium subsamples have been sent to Mercury, the sample cans containing any remaining soil are shipped to the Nevada Test Site for storage at Building 2106 in Area 26.

D. Recordkeeping

There are five recordkeeping items used by the soil-preparation laboratory.

1. Daily Logbook

The soil-preparation-laboratory personnel keep a daily record of work performed. Information recorded includes which samples are being processed and at what stage the samples are in the preparation procedure.

2. Soil-Prep Worksheets (Figure D1)

The worksheets are used to record soil weights during the soil-processing procedure. Completed worksheets are placed in a notebook, which is kept in the soil-preparation laboratory.

3. File Cards (Figure D2)

A file card, REECo form RE-0555, is kept for each sample-ID number generated by DRI. The cards are kept in numerical order beginning with 72001. This allows immediate and rapid access to each sample in the file. All sample numbers, including QA and "practice" samples, are included in this file.

The file cards contain the following types of information:

- sample- or subsample-ID number
- date processing started
- date processing completed
- final weights of both fine and coarse fractions
- date gamma subsamples sent to Mercury for analysis
- date gamma-analysis results are received from Mercury
- date plutonium subsamples prepared and sent to Mercury for analysis

- date plutonium-analysis results received from Mercury
- date sent to Nevada Test Site for storage
- notation indicating that only an "A" gamma subsample exists

4. Can Lids (Figure D3)

The fine soil fraction of each sample is stored in one or more one-gallon cans. The following information is written on the can lids:

- sample-ID number
- number of cans per sample
- notation indicating that a coarse fraction does not exist
- notation indicating that only an "A" gamma subsample exists
- temporary preparation number

Materials and Equipment for Soil-Preparation Laboratory

Vacuum cleaner, 5-gallon capacity
Sieves, 8" diameter, 32-mesh with pan and cover
Electrician's tape for sieves, 1-1/2" width
Spatulas, 3/4" x 5" blade
Surgical gloves
Asbestos gloves, long sleeved
Metal tool trays
Aluminum trays, 7" x 10" and 13" x 21"
Wire-bristle brushes
Scissors
Plant shears, 8" heavy blades, vertical action
Heavy-duty can opener
Vibrating spatula, Mettler Vibro-Spatula
Vibrating shaker, Derrick Lab Test
Polypropylene funnels, 8" diameter
Tongs
Soil scoop
Triple beam balance, capacity 30 kg
Platform scale, 5 kg, direct reading
Detergent for sonic cleaner
Sonic cleaner, 9" width, Bransonic B-52 with cover
Paper towels and Kimwipes
Ovens, capable of 105°C when loaded
Ball mill
Steel balls, 1" diameter
Nalgene bottles, 500-ml and 175-ml
Cans, 1-gallon, with lids and lid clips
Flow pens
Soil-Prep Worksheets
Laboratory Services Request form (RE-1585)
File cards (RE-0555)

SOIL PREP WORKSHEET

	1	2	3	4	5 (0-3)	6	7	8 (7-8)	9	10 (9-6)	11 (8-10)	12 (11/10)	13	14	15	16	17 (1000-1000)	18	19	20
Soil I.D. Number	Date Received	Gross Wet Sample Weight Plus Bag	Empty Bag Weight	Gross Wet Sample Weight	Container Weight	Wet Sample Weight Plus Container	Wet Sample Weight	Dry Sample Weight Plus Container	Dry Sample Weight	Moisture Content	Moisture Ratio	Ball Mill #1 Coarse Weight	Ball Mill #2 Coarse Weight	Ball Mill - #3 Final Coarse Weight	Final Weight on Fine	Percent Coarse	Date Finished	Date Sent for Counting		
72345	8/22	5209		A	285	1962		1966												
				A	284	1956		1858												
				C	281	1952		1856												
TOTAL	→	5209	173	5036	840	6870	5030	5590	4740	290	6.1	470	215	93	4647	2.00	8/31		ES	
72344	8/22	4824		A	284	1844		1663												
				B	287	1839		1660												
				C	284	1838		1658												
TOTAL	→	4824	156	4668	855	5520	4665	4781	4126	539	13.1	146	68	25	4100	.61	9/2		~~AA~~	
72351	8/22	6102		A	283	1751		1524												
				B	286	1756		1530												
				C	285	1752		1527												
				D	281	1728		1503												
TOTAL	→	6102	234	5868	1135	6987	5852	6084	4949	903	18.2	1431	675	112	4852	2.31	9/2		~~AA~~	
72341	9/1	4587		A	283	1762		1554												
				B	281	1758		1550												
				C	282	1762		1553												
TOTAL	→	4587	145	4442	846	5282	4436	4657	3811	625	16.4	304	127	34	3777	.90	9/1		~~AA~~	

Figure D1. Soil-Prep Worksheet

72345	9·22·83 8·31·83 E³		93g (Coarse) 1-16 oz bottle Original Archiving Weight 4647g (Fine) 1 Can	
DATE OUT	**REQUESTER (Organization, Name, Address)**	**REMARKS**	**DUE DATE**	**DATE RETURN**
9-6-83	NTS	1-500 ml		9/26/83 137 Cs Results
2-84	Composited	72345 + 72340 = 192		
	Storage			
12·26·84 12·28·84	Composited Storage	72345+72340:327 36.2g+163F₂		

RE-0555 (3/80)

Figure D2. RE-0555 File Cards

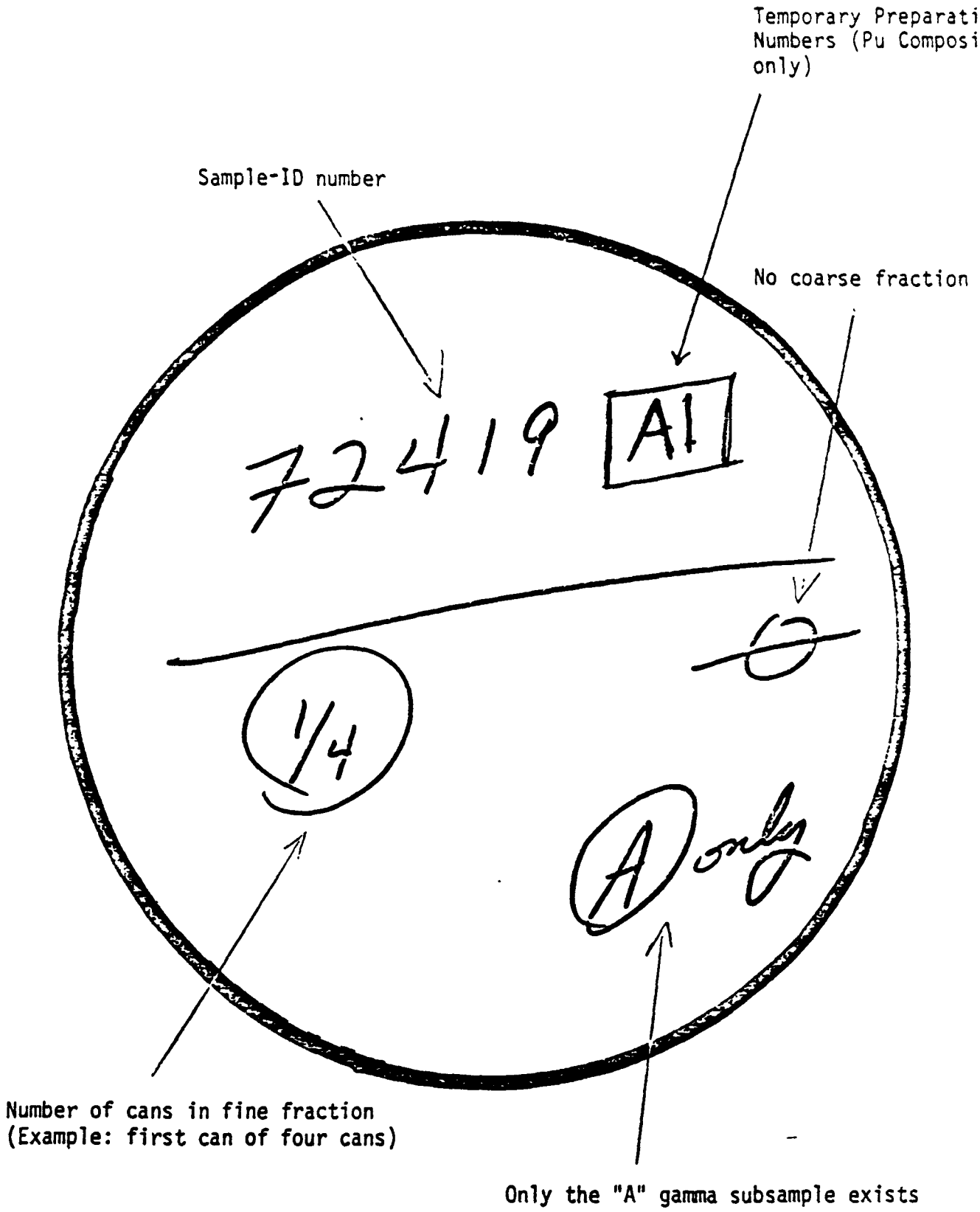

Figure D3. Example of Fine Fraction Can Lid

1	2	3	4	5	6	7	8	9	10	11	12	13	14
GROSS WT.	BAG WT.	GROSS WET WT.	WET WT.	DRY WT.	# OF CANS	MOISTURE CONTENT	% MOISTURE (RATIO)	COARSE SM #1	COARSE B.M #2	COARSE BM #3	PWE WT.	% COARSE	
72405 10-3-83													
5202	153	5049	5028	4115	3	913	22.19	489	259	7	4096	.17	1
72413 10-3-83													
4599	168	4431	4424	3524	3	900	25.54	10	4	2.3	3533	.07	1
72416 10-3-83													
5368	291	5077	5055	4511	3	544	12.06	1922	784	230	4307	5.3	1
72417 10-3-83													
5468	145	5323	5316	4018	3	1298	32.30	48	20	13.7	4007	.34	1
72418 10-3-83													
5175	335	4840	4827	4237	3	585	13.81	1559	10.10	541	3704	12.74	1
72419 10-3-83													
3591	154	3437	3426	2844	2	582	20.46	84	7	7	2844	.25	1
72406 10-3-83													
4032	222	3860	3560	3234	3	626	19.36	830	406	156	3092	4.80	1
72409 10-3-83													
4875	130	4745	4738	3783	3	955	25.24	104	17	6	3775	.158	1

Figure D4. ORERP Data Logsheets

APPENDIX E

PROJECT DIRECTIVE NO. 4
SPECTROSCOPIC ANALYSIS AND CHEMICAL SEPARATION PROCEDURES

SPECTROSCOPIC GAMMA ANALYSIS

1. Each soil sample received from the soil-preparation laboratory will be dried, ground, homogenized and packaged in 500-ml polethylene bottles for gamma counting. The bottles are to be filled to a consistent volume.

2. Samples will be weighed before counting.

3. The samples will be analyzed on intrinsic-germanium detectors, initially for 300 minutes. The resulting data will be analyzed for cesium-137, radium-226 and -228, thorium-232, and potassium-40, and the analytical results will be reviewed by the laboratory project officer. Attention will be paid to the density of the sample, and corrections for varying absorption will be made by incorporating a factor obtained from calibration curves generated from soils of varying densities.

4. The gamma-analysis results will be reported directly to DRI, who will determine whether the statistical precision of the cesium-137 activity meets the project criterion. If necessary, the sample will be recounted for 1000 minutes and the new activity reported to DRI.

5. With each group of 8-12 samples, an internal laboratory-quality-assurance sample will be analyzed to maintain the required accuracy.

6. After analysis, the soil sample will be stored.

CHEMICAL SEPARATION OF PLUTONIUM

1. Samples to be chemically analyzed for plutonium will be received from the soil-preparation laboratory in 200-gram aliquots.

2. The samples will be processed by leaching the plutonium from the soil with nitric and hydrochloric acids. The specific steps of the procedure are described at the end of this Appendix.

3. The plutonium will be electroplated on platinum disks for subsequent alpha-spectroscopy and mass-spectrometry analysis.

4. The plutonium activity of the discs will be counted for 1000 minutes by surface-barrier detectors that have active areas of 300 mm^2.

5. After data reduction and plutonium-activity calculation, the results will be reviewed by the laboratory project officer.

6. The following plutonium-analysis results will be reported to DRI with a copy going to EML:

   a. The date of the radioassay, the counting time and the detector used.

   b. The quantity of plutonium-236 added, corrected to the counting date.

   c. The net counts in the plutonium-236 and plutonium-239+240 regions of the alpha spectrum, their Poisson uncertainties and the resolution of each peak.

   d. The calculated dpm/g of plutonium-239+240 in the sample with an expression of uncertainty that includes uncertainty in calibration and chemical recovery.

   e. The most current four primary or secondary detection-efficiency checks and background for each detector.

7. The platinum disks on which the plutonium has been deposited will be stored, and at the direction of the REECo Soil-Sample Project Director, will be shipped to the laboratory that will perform the mass-spectrometry analyses. Following mass isotopic analyses, the platinum disks will not be reused in this project.

8. The Desert Research Institute will administer the project's quality-control program and will assign sample numbers of approximately 10 percent of the samples processed by REECo that will be used for quality-control evaluations. The identification of these samples will not be known to REECo. In addition to the DRI selected QA samples, EML will submit reference soils and spiked samples to the REECo laboratory through DRI, for inclusion in the overall QA evaluation program.

PLUTONIUM ANALYSIS OF SOIL

Scope

Plutonium deposited in surface soils from worldwide fallout can be completely leached and analyzed to determine its concentration. Plutonium may not be completely recovered by the leach process from larger particles originating from the NTS but that will not adversely affect the final result. Primary plutonium analysis will be limited to the leach process described herein.

Principle

Plutonium isotopes are leached and equilibrated with plutonium-236 tracer with nitric and hydrochloric acids from soil samples 200 g in size. Subsequently, the plutonium isotopes are collected with iron hydroxide, further purified by ion-exchange, then finally electrodeposited on a platinum disc. The plutonium isotopes are measured by alpha spectrometry.

Special Apparatus

1. Virgin platinum disks - 17.6 mm dia. x 0.005 mm, mirror finish on one side

2. Electrodeposition plating cells

3. Ion-exchange columns

4. Double vented conical gravity funnels

5. Polyethylene tracer dispersing bottle

Special Reagents

1. Plutonium-236 tracer: A solution in a dispensing bottle that has been standardized to about 10 dpm/g. The purity of the tracer has been measured by alpha spectrometry.

2. Fe^{+3} carrier (100-mg Fe/ml): Slowly dissolve 100 grams of Fe wire in 500 ml of concentrated HCl. Cool and add slowly 50 ml of concentrated HNO_3 with stirring. Cool and dilute to 1 liter with H_2O.

3. Standardized 0.1N NaOH.

4. Eluting agent: 0.4N HNO_3 - 0.01N HF.

5. Anion exchange resin: Bio-Rad AG 1 x 4 (100-200 mesh, Cl^- form).

6. Methyl red indicator: Dissolve 100 mg of the dye in 65 ml of 95% ethanol and dilute to 1 liter with H_2O.

7. Phenolphthanlein indicator: Dissolve 500 mg of reagent in 100 ml of 95% ethanol.

Sample Preparation

Leach Technique

1. Weigh 200 g of prepared soil into an appropriately sized beaker. Add a measured amount of plutonium-236 tracer solution (2-3 cpm) from the dispensing bottle.

2. Place a glass stirring rod in the beaker and cover with a watch glass. Immerse the beaker in an ice-water bath. Cautiously add 500 ml of concentrated HNO_3. Control sample foaming by the addition of a few ml of n-octyl alcohol. When the reaction ceases, cautiously add 150 ml of concentrated HCl. DO NOT STIR. Remove the beaker from the ice-water bath, allow the sample to stand at room temperature for 2-4 hours, then gradually heat the sample on a low temperature hot plate overnight. The temperature should be high enough so that refluxing occurs.

3. Evaporate the solution mixture to about 300 ml, add an equivalent amount of H_2O, cool and let settle. Filter through two 24-cm Whatman #42 filters on a Buchner funnel. Wash the residue consecutively with 100-ml

each of 7.5N HNO_3 and H_2O. Collect the filtrate and transfer to a 3-liter beaker.

4. Transfer soil residue and filter back to the original beaker. Add 500 ml of concentrated HNO_3 and slowly add 150 ml of concentrated HCl. DO NOT STIR. Allow the mixture to react at room temperature for 1 hour. Heat on a hot plate overnight at reflux temperature.

5. Evaporate the filtrate from step 3 to reduce the sample volume.

6. Repeat steps 3 through 5 at least twice, making a total of 4 leachings and filterings. The leaching is complete when the soil appears to be white to gray in color. Retain the filter paper and soil residue.

7. Evaporate the combined leachates to about 300 ml; cover with a watch glass and boil to oxidize the organic matter under refluxing conditions.

8. Continue to boil and add concentrated HNO_3 in 10- to 20-ml increments as needed to maintain the volume at 300 ml, to avoid salting out, until all organic material is decomposed. If a precipitate is observed, TiO_2 is present in the sample. If this occurs, a fluoride collection of plutonium has to be performed rather than iron hydroxide described in the following steps. For the fluoride collection, follow Note #1.

9. Cool and dilute the solution with an equal volume of H_2O. Add 30 ml of 30% H_2O_2 to reduce Pu^{x} to Pu^{III+IV}.

10. Add 100 mg of iron-carrier solution and adjust to pH 8 by slowly adding NH_4OH. Heat until the precipitate coagulates.

11. Filter the precipitate on a 24-cm Whatman #42 filter contained in a double vented conical funnel. Wash the precipitate with 1.2N NH_4OH and discard the filtrate.

12. Transfer the filter containing the precipitate to the original beaker in Step #11. Add 200 ml of concentrated HNO_3, cover with a watch glass and heat on a medium-heat hot plate until the precipitate and filter decompose.

13. Cool, add 200 ml of H_2O and 30 ml of 30% H_2O_2. Neutralize with NH_4OH and adjust to pH 8. Heat to coagulate the precipiate.

14. Filter the precipitate as described in Step #11 and discard the filtrate.

15. Repeat Step #12.

16. Evaporate the sample to 100 ml, add an equal volume of water and filter the SiO_2 precipiatate onto a 24-cm Whatman #42 filter. Wash the precipitate with 1:1 HNO_3, collect the filtrate in a 1 liter beaker and reserve.

17. Transfer the filter and precipitate to a 250-ml glass beaker, dry at 100°C, and carefully heat to 400°C. Cool and transfer to a 250-ml Teflon beaker.

18. Add 25 ml of concentrated HNO_3 and 10 ml of concentrated HF to the residue in the Teflon beaker. Evaporate to dryness, repeat the addition of acids and evaporation two more times.

19. Add 25 ml of HNO_3 saturated with H_3BO_3 and evaporate to dryness. Dissolve the residue with 1:1 HNO_3 and combine with the filtrate from Step #16.

20. Evaporate the combined solution to about 200 ml. Cool to room temperature, transfer to a 250-ml graduated cylinder and record the volume.

21. Dispense two 100-microliter aliquots into 150-ml beakers containing 25 ml of water. Add 2-3 drops of 0.5% phenolphthlein solution. Titrate the two aliquots with standardized 0.1N NaOH to the phenolphthalein end point. Calculate the acid normality of the sample solution.

22. Return the sample from the graduated cylinder to the original beaker. Wash the cylinder with the amount of 1N HNO_3 necessary to adjust the final normality of the sample solution to 8N HNO_3.

23. Cool the sample to room temperature and add 1 g of hydroxylamine hydrochloride and stir until dissolved.

24. Heat the solution to 90°C and decompose all the hydroxylamine hydrochloride. (No further evolution of gases is observed.) Add 200 mg of sodium nitrite. Continue to heat until the evolution of nitrogen oxides ceases. Cool the sample to room temperature.

25. Prepare ion-exchange-resin column #1. (See Note #2). Wash about one-half of the ion-exchange resin into the sample and stir for 5 minutes. Transfer the sample and the resin to column #1.

26. Pass the solution through the resin beginning at full flow, 1 ml/min. Make certain that all the resin particles adhering to the beaker or resin funnel are washed into the resin bed with 8N HNO_3. Wash the column three times with 30 ml of 8N HNO_3. Allow the liquid to flow until the level reaches the top of the resin bed. Reserve the sample and wash effluent until the plutonium-236 tracer yield has been determined as satisfactory, after which it can be discarded.

27. Elute the plutonium with 200 ml of 0.4N HNO_3-0.01N HF. Discard the resin.

28. Evaporate the eluate to dryness. Add 5 ml of HNO_3 and evaporate to dryness. Repeat the HNO_3 addition and evaporate two more times.

29. Dissolve the residue in 15 ml of 8N HNO_3, and repeat Step #23.

30. Repeat Step #24.

31. Prepare ion-exchange resin column #2. (See Note #3). Wash about one-half of the conditioned resin into the sample with 8N HNO_3 and stir for 5 minutes. Transfer the sample and the resin to column #2.

32. Pass the solution through the resin bed at full flow, 1 ml/min. Make certain that all resin particles adhering to the beaker and column reservoir are washed into the resin bed with 8N HNO_3. Allow the liquid to flow until the level reaches the top of the resin bed. Discard the effluent.

33. Wash the resin with four 10-ml portions from a freshly opened bottle of HCl, and allow each addition to pass through the column until the level reaches the top of the resin bed. Wash the resin with three 10-ml portions of 8N HNO_3 and allow each addition to reach the top of the resin bed. Discard the wash effluents.

34. Elute the plutonium with 200 ml of 0.4N HNO_3 - 0.01N HF solution. Discard the resin.

35. Evaporate the eluate to dryness. Convert the residue to the chloride form by twice adding 1 ml of HCl and evaporating to dryness.

Plutonium Electrodeposition

1. Add 1 ml of HCl to the residue and warm gently (50-60°C). Transfer the solution with a transfer pipet to an electroplating cell. Wash the beaker and pipet with three 1-ml portions of hot water and transfer to the cell.

2. Add 1 drop of 0.1% methyl red indicator. Add NH_4OH drop by drop until the solution turns yellow. Add a minimum amount of 1:5 HCl one drop at a time until the solution is red, then add 2 drops of 1:5 HCl in excess.

3. Dilute to 5 ml with water. Electroplate at a current of 1.2 amperes for about 1 hour.

4. At the end of the electroplating, wash down the cell walls with water and neutralize the electrolyte with 1 ml of NH_4OH. Discard the solution, dismantle the cell and rinse the electroplated disk with water and 95% ethanol.

5. Flame the disk over a burner to red heat. Cool. Count the disk on an alpha spectrometer. Calculate the plutonium-236 recovery and determine the activity of the plutonium isotopes.

Note #1 - Fluoride Collection of Plutonium

1. Cool the solution to room temperature and transfer to a 500-ml Teflon beaker with H_2O.

2. Add 1 g of hydroxylamine hydrochloride and stir until dissolved.

3. Add 10-ml portions of HF with stirring until all of the TiO_2 precipitate dissolves, then add 10 ml of HF in excess.

4. Add 100 mg of purified yttrium carrier solution. See U.S. DOE Environmental Measurements Laboratory (EML) Procedures Manual, 1983, 26th Edition, Section E-Sr-01, for preparation procedure.

5. Allow the fluoride precipitate to stand for an hour.

6. Transfer the precipitate and solution to several 90-ml polyethylene centrifuge tubes and centrifuge for two minutes. Discard the supernatant.

7. With a plastic stirring rod, stir the precipitate in each centrifuge tube thoroughly with 10 ml of 1:1 HNO_3 and 10 ml of HF and let stand for about 5 minutes. Remove the plastic stirring rod and wash with H_2O.

8. Centrifuge for two minutes and discard the supernatant.

9. Add 30 ml of saturated boric-acid solution, stir and add 25 ml of HCl to each centrifuge tube. Stir with plastic stirring rod to dissolve.

10. Transfer and combine the solutions from the centrifuge tubes in the original Teflon beaker, then continue with Step #9 of Sample Preparation.

Note #2 - Column #1 Preparation

The column is described in Specification G-05 of the U.S. DOE Environmental Measurements Laboratory Procedures Manual, 1983, 26th Edition. Position a plug of glass wool at the base of the column. Add 25 ml of wet resin, BioRad-Ag 1 x 4 (100-200 mesh, Cl^- form). Wash the resin with 50 ml of 0.4N HNO_3 -0.01N HF solution. Pass 250 ml of 8N HNO_3 through the resin or a sufficient volume to remove all chlorides as shown by a negative silver-nitrate test.

Note #3 - Column #2 Preparation

The column is described in Specification G-05, except that the outside diameter is 11 mm. Add 5 ml of resin and condition the resin as outlined in column #1.

APPENDIX F

PROJECT DIRECTIVE NO. 4
QUALITY ASSURANCE

The Quality-Assurance Program for the analyses performed on soil samples collected in support of dose assessment in the extended region contains quality-control procedures intended to verify that the processes--soil preparation, cesium radioassay, plutonium analysis and isotope mass spectral analysis--are being performed to specified standards, and additional quality-assessment procedures to provide necessary information on the overall quality of the results. Quality assurance includes both quality control and quality assessment, as well as use of standardized techniques and verification of performance of critical steps.

The entire analytical process, beginning with soil preparation, is performed on soil that has had location and depth information replaced by identification numbers assigned at random. Quality-control samples are also assigned numbers at random and packaged in such a way that they are indistinguishable from other soil samples.

Soil Preparation

At the soil-sampling sites, four plastic bags are filled with the increments of the 10 soil columns, labeled, and placed in a cloth bag for shipment to Las Vegas. Appendix C describes this procedure. The unopened cloth bags are stacked in the storage area of the soil-preparation facility until needed.

The cloth bags are typically grouped for convenience into sets of six bags for entry into the soil-preparation laboratory. The 24 plastic bags of soil fill three shelves in the facility. Up to three sets of cloth bags are set up at a time, depending on the available shelf space.

The first step is to assign laboratory numbers at random to the logbook entries for the 24 plastic bags. The cloth bags are then opened, and the plastic bags from each sampling site are arranged in vertical increment order to ensure that the correct laboratory number will be applied to each bag. Relabeling the bags is a three-person operation conducted by DRI. One person removes the identifying tag from the bag and tapes over the label, the second person reads the laboratory number from the logbook, and the third person writes the number on the tape and reads it back for verification. Depending on convenience, either the first or third person places the relabeled plastic bags on the shelves, making sure bags from the same sampling site are not placed together.

The logbook entries are signed by the DRI personnel involved in the process. The logbook is kept at DRI, a copy is kept at DRI in a fireproof safe, and another copy is sent to EML. Appendix D describes the soil-preparation procedure.

Blank soil from EML is assigned a random number and inserted into the soil-preparation stream at a rate of about 4 percent to check for contamination in the soil-preparation facility. If the cesium-137 content of the blank soil is greater than 2.33 times its counting uncertainty, the blank sample is recounted. If the cesium-137 activity of the recount is not significantly different from zero, all samples between the last acceptable analysis of the blank soil and the next acceptable analysis of the blank soil will be recounted. If the cesium-137 value of the recount is still greater than 2.33 times its counting uncertainty, data from all samples processsed in the soil-preparation laboratory between the last acceptable analysis of the blank soil and the next acceptable analysis of the blank soil are suspect and must be qualified. The Project Manager, upon the recommendation of the Scientific Director, may decide to discard these data and to recollect and reanalyze new soil samples. The probability of incorrectly rejecting an acceptable preparation of blank soil, α, is set at 0.01. This determines the selection of the 2.33 criterion.

Gamma Spectral Analysis

The general procedure for the gamma spectral analysis of the soil sample for cesium-137, as given in Appendix E, was approved by EML. Since the counting geometry used by REECo differs from that used by EML, a series of interlaboratory comparisons of typical soil samples is being conducted to calibrate the REECo system against the EML system and vice versa. This will assure that the analyses now being made and the 1979 EML Utah study are consistent. Appropriate corrections will be made if necessary to normalize the REECo results to EML standards. All cesium-137 data will be decay corrected to January 1, 1983.

A large amount of soil was collected in Utah, pulverized and carefully homogenized to serve as a quality-control standard sample. It was then aliquoted into bottles for gamma spectroscopy and for plutonium analysis. The bottles prepared for gamma analysis are randomly inserted in the process stream at a frequency averaging 10 percent. For each of cesium-137, potassium-40, radium-226, and the average of thorium-228 and radium-228, there is a reference-soil mean and standard error. If the difference between a measured value and its mean is greater than 2.50 times the standard deviation of that difference, then all samples radioassayed since the last acceptable analysis of the reference soil and before the next acceptable analysis of reference soil will be recounted and the original data disregarded. The probability, α, of incorrectly rejecting a radioassay of reference soil is .05 under the assumption of joint independence of isotope concentrations. The assumption of joint independence is physically reasonable for several pairs of radionuclides. The correlation between those pairs of radionuclides for which joint independence fails to hold is positive. That will result in a smaller true α than the α given.

The natural activity of the blank soil will also be used in a similar manner to test the reliability of the gamma spectrometric measurements because a mean and standard deviation of those activities will also be available.

As part of quality assessment, DRI will also submit blind duplicate aliquots of samples, selected at random, for radioassay at a frequency of 10 percent. The results of these duplicate analyses will provide an estimate of the combined uncertainty of homogeneity of prepared soil samples and precision of analysis. The information gathered in both programs will provide a statistical assessment of the quality of the final data set.

There are quality-control as well as quality-assessment aspects to submission of duplicate aliquots. If two aliquots differ by more than 2.50 times the standard deviation of their difference in cesium-137, potassium-40, radium-226, or the average of radium-228 and thorium-228, then both aliquots will be recounted. The probability, α, of erroneously deciding that the aliquots are different is .05 under the assumption of joint independence of isotope concentrations.

If the recounting still yields values outside the acceptance region, then the presumption is that the soil mixture was not sufficiently homogenized. New aliquots will be prepared and counted, and the old data will be disregarded. In addition, the soil samples on either side of the suspect sample in the soil-preparation stream will have duplicate aliquots counted. On the other hand, if the recounted aliquots do agree, the older data will be disregarded, and the samples in the sample-counting stream on either side of the aliquot which yielded significantly different results upon recounting will be recounted. The record will show what samples have been disregarded and why.

Another dimension of quality control for gamma spectral analysis is based upon expected physical relationships between the activities of samples representing different depth increments of the same soil core. It does not operate in the processing stream because the samples from a single core are usually counted at different times and because some of the information necessary for the interpretation will not be available until a substantial number of samples has been analyzed. The tests used can justify questioning the analyses of a single sample or several samples from the same core.

There are three conditions which will be used to flag a sample analysis or set of sample analyses as suspect:

1) The cesium-137 activity in the soil core from a given site fails to decrease with depth in the soil and to approach zero at a depth of 30 centimeters, possibly indicating a poor analysis, a mix-up in sample identification, or a disturbed sampling site.

2) The integrated cesium-137 deposit in a soil core is (a) less than 60 percent of that expected from global fallout, or (b) differs by more than 30% from that predicted by the in situ analysis for that site using the measured depth profile. The expected cesium-137 from global fallout can be estimated from average annual precipitation as discussed in the paper, "Radiation Exposure in Utah from Nevada Nuclear Tests," by H. L. Beck and P. W. Krey, found in Science, April 1, 1983, pages 18-24, which gives the expected relationship for cities in Utah. This exact relationship is not expected to be valid for other parts of the Phase II region, but similar relationships can be derived from the soil data in a manner similar to that used in EML-400* and should provide global fallout estimates of about $\pm$ 13 percent (1 S.D. as was the case for Utah).

3) The variation of natural gamma activity with depth in the soil is inconsistent with the internal norms established by estimating the empirical distributions of the variance of natural activity within a soil core.

When the results of the natural radionuclide measurements for one or more samples in a core fall outside this range of acceptability, these data are suspect, particularly if the corresponding cesium-137 analyses are anomalously high or low in the same direction (refer to

* Krey, P. W. and H. L. Beck, "The Distribution Throughout Utah of ^{137}Cs and $^{239+240}Pu$ from Nevada Test Site Detonations," November 1981. (DOE/EML-400)

test number 1). The logic is that a measurement that gives suspicious natural radionuclide results might also provide suspect cesium-137 results.

Once a sample result or set of results is flagged as suspicious by one or more of the above tests, a complete review of the sample collection, preparation, and analysis history will be made to search for errors in weighing, transcription, or calculations. If the suspicion remains, the aliquots of the suspicious sample or samples should be recounted, assuming a duplicate analysis has not already been done. If the recount agrees with the original analysis and test 3 was failed, new aliquots should be analyzed. In any case, the difference between recounts of normal-looking samples versus "flagged" samples will provide an assessment of any possible biasing. If, at the end of the analyses for cesium-137, such a bias appears to have occurred, additional "normal" samples will be randomly selected and recounted.

Plutonium Analysis

The procedure for the radiochemical analysis of plutonium was specified by EML and is contained in Appendix D. Ten soil samples are batched and processed together by the radiochemist. In each batch will be two of three standard soil samples. A blank sample (containing natural activity, but no plutonium) and one of the standards were supplied by EML. The other standard soil was collected in Southern Utah. As part of the quality assessment, the results from the duplicate aliquots will indicate the homogeneity of the plutonium in the prepared soil and precision of plutonium analysis, while the results from all the standard soils and blanks will provide a statistical assessment of the overall quality of the plutonium analyses.

Some quality-control checks, during the plutonium radiochemistry analysis, affect individual samples and others affect batches of samples. Any sample with a chemical tracer yield of less than 30 percent will be discarded, and a new aliquot will be analyzed.

If the resolution of the plutonium-alpha spectrum is greater than 80 keV at full width half maximum, the sample should be recounted. If the second measurement confirms the poor resolution (> 80 keV), the data are unacceptable and additional chemistry will be performed.

If the alpha spectrum contains peaks of other radionuclides in the 5 to 6 MeV energy range, the data are unacceptable and further chemistry is required. All samples will be alpha counted twice, each time for 1,000 minutes, to provide improved precision of analysis. If the difference between the two concentration estimates is larger than 1.96 times the standard deviation of the difference ($\alpha = .05$) this will result in recounting the platinum disk. If the recount fails to agree with either of the first two counts, the data will be rejected and a new aliquot of soil will be analyzed for plutonium. The distribution of these duplicate counts will provide an assessment of the quality of the alpha-counting step.

If the results of the plutonium analysis of the standard soils and the blank in a batch fall outside the range of acceptability, all samples in the batch will be realiquoted and analyzed, and the original data will be discarded. The probability levels for the tests will be adjusted, depending on the presence or absence of a blank sample, so the probability, α, of incorrectly rejecting a batch is .05.

Let X_i and S_i be the value and counting error of the i^{th} standard soil which has mean value $\bar{X}_i$ and standard error $S_{\bar{X}_i}$ for i equal to 1 or 2. The tests to be applied are:

1) Reject the batch if $|\bar{X}_i - X_i| > K_1 \left(S_i^2 + S_{\bar{X}_i}^2\right)^{1/2}$
   for $i = 1$ or 2.

2) Reject the batch if $\bar{X}_1 - X_1 > K_2 \left(S_1^2 + S_{\bar{X}_1}^2\right)^{1/2}$

   and

   $\bar{X}_2 - X_2 > K_2 \left(S_2^2 + S_{\bar{X}_2}^2\right)^{1/2}$

3) Reject the batch if $X_1 - \bar{X}_1 > K_2 \left(S_1^2 + S_{\bar{X}_1}^2\right)^{1/2}$

and $X_2 - \bar{X}_2 > K_2 \left(S_2^2 + S_{\bar{X}_2}^2\right)^{1/2}$

4) Reject the batch if the value obtained for the blank is more than K_3 times the estimated uncertainty.

	Blank Present	Blank Absent
K_1	2.57	2.49
K_2	2.33	2.23
K_3	2.33	---

Invoking the same logic as described for the cesium-137 radioassay, quality control may require analysis of a new aliquot when one of the following conditions exists:

1) The integrated plutonium-239+240 deposit in the soil core from a given site is less than 60 percent of the expected global fallout value for that site. The expected global plutonium deposit can be derived from the expected global cesium-137 deposit since the ratio of the two is well known (see EML-400).

2) The cesium-137/plutonium-239+240 activity ratio of a sample is greater than 70 in one of the two depth increments of a single core.

3) The cesium-137/plutonium-239+240 activity ratio of the next lower soil depth increment increases by more than 50 percent.

As in the case of cesium-137 analyses, once a sample result or set of results is flagged as suspicious by one or more of the above tests a complete review of the sample collection, preparation, and analysis history will be made to search for errors in weighing, transcription, or calculations. This procedure

will be followed before reanalyzing any samples due to any of the quality-control steps in this plan. If suspicion remains, a new aliquot will be analyzed.

Plutonium Mass Isotopic Analysis

The plutonium mass isotopic analyses will be performed under contract by the Pacific Northwest Laboratories, a recognized expert facility for these measurements. As part of the quality assessment, the global plutonium inferred from the results of the duplicate aliquots will indicate the overall precision of the mass isotopic and plutonium analysis, integrating all the sources of uncertainty from sampling the soil to the final mass determination. Similarly, the mass isotopic results of the standard soil samples processed through the radiochemistry will provide data to assess the precision of the mass isotopic results of a typical soil sample.

The only quality-control procedure specifically for mass isotopic analysis will be submission at a rate of about 6 percent of platinum disks, indistinguishable from routine samples, onto which standard solutions of plutonium with a known mass isotopic content (traceable to the National Bureau of Standards) have been electroplated. These disks will be supplied by EML.

Although the precision of the plutonium mass isotopic analysis is usually less than $\pm$ 1 percent and the accuracy greater than 99 percent, this program does not require results of such high quality. Consequently, if the results of the standard sample are greater than $\pm$ 5 percent of the calibrated value, all the platinum disk samples that were analyzed in the same batch or since the last and next acceptable analyses of a standard sample should be realiquoted and reanalyzed.

Additional Quality Assessment

In addition to the above program, EML has collected and will independently analyze soils from 13 of the sites sampled by REECo. The comparision of the results from this duplicate site sampling will provide an independent assessment of the cumulative quality of the entire soil-collection, soil-

preparation, and soil-analysis program. Similar data will also be obtained from a comparison of the REECo and EML results for the six sites previously sampled by EML in 1979 and resampled by REECo in 1983.

APPENDIX B

List of Potential Sampling Sites

Appendix B. List of Potential Sampling Sites

This table lists all the potential sampling sites identified by DRI as well as alternative sites chosen by LLNL and REECo and the five EML sites resampled by the ORERP. The sites sampled in 1986-87 are listed after the 1982-85 sites.

The information in the numbered columns is as follows:

Column 1 gives the <u>in situ</u> measurement of ^{137}Cs (in nCi/m^2).
Column 2 shows where soil samples were collected.
Column 3 shows which sites were submitted for gamma-ray spectrometry.
Column 4 shows which sites were submitted for plutonium analysis.
Column 5 shows which sites were submitted for isotope mass spectroscopy.

ID	Location			1	2	3	4	5
AF01	Talmage	UT	private lawn	38	X	X	X	X
AF02	Ashley NF	UT	Bennion Park	172	X	X		
AF03	Ashley NF	UT	Jefferson Park	--				
AF04	Talmage	UT	private lawn	34	X			
AF05	Talmage	UT	private lawn	37	X	X	X	X
AF06	Ashley NF	UT	Mill Park	214	X			
AF07	Bridgeland	UT	private lawn	32				
AF08	Bridgeland	UT	private lawn	--				
AF09	Arcadia	UT	private lawn	55	X			
AF10	Arcadia	UT	private lawn	--	X			
AF11	Upalco	UT	private lawn	23	X			
AF12	Altonah	UT	private lawn	31	X			
AF13	Ashley NF	UT	Center Park	170	X			
AF14	Mt. Home	UT	private ranch	45	X	X	X	X
AF15	Ashley NF	UT	Long Park	--				
AF16	Altonah	UT	private farm	62	X			
AF17	Altonah	UT	high school	--				
AS01	Farmington	NM	Fairgrounds Park	48	X	X		
AS02	Farmington	NM	Jaycee Park	20				
AS03	Farmington	NM	private lawn	35	X			
AS04	Kirtland	NM	private lawn	--				
AS05	Kirtland	NM	private lawn	32	X			
AS06	Cortez	CO	Montezuma Park	34	X	X	X	X
AS07	Cortez	CO	Cortez Park	30				
AS08	Mancos	CO	private lawn	46	X	X		
AS09	Mancos	CO	private lawn	--				
AS10	Durango	CO	Old High School Park	34	X	X	X	X
AS11	Durango	CO	Greenmount Cemetery	34	X			
AS12	Durango	CO	private lawn	29				
AS13	Silverton	CO	County Courthouse	50	X	X	X	X
AS14	Silverton	CO	private lawn	76	X			

AS15	Telluride	CO	private lawn	--				
AS16	Telluride	CO	private meadow	60	X			
AS17	Montrose	CO	Post Office	38				
AS18	Montrose	CO	Cedar Cemetery	44	X			
AS19	Montrose	CO	Buckley Park	28				
AS20	Montrose	CO	Lions Park	37	X	X		
AS21	Fruita	CO	Fruita Junior High	40	X	X	X	X
AS22	Fruita	CO	Public Library	39				
AS23	Rifle	CO	private lawn	33				
AS24	Rifle	CO	Rifle Junior High	44	X			
AS25	Meeker	CO	City Park	51				
AS26	Meeker	CO	County Courthouse	51	X	X	X	X
AS27	Craig	CO	Craig City Park	84	X	X	X	X
AS28	Craig	CO	Yampa School	49	X	X		
AS29	Green River (?)	WY	[records lost]					
AS30	Green River (?)	WY	[records lost]					
AS31	Rock Springs	WY	County office	34				
AS32	Rock Springs	WY	Bunnings Munic. Park	36	X	X	X	X
AS33	Evanston	WY	County Courthouse	48				
AS34	Evanston	WY	City Cemetery	28				
AS35	Evanston	WY	Hamblin City Park	49	X	X	X	
AS36	Kemmerer	WY	Golf Course	77	X	X	X	X
AS37	Kemmerer	WY	Cemetery	--				
AS38	Kemmerer	WY	Triangle Park	34	X			
AS39	Afton	WY	City Park	71				
AS40	Afton	WY	Cemetery	65				
AS41	Afton	WY	U. of W. Res. Ctr.	72	X	X	X	X
AS42	Idaho Falls	ID	Highland Park	17				
AS43	Idaho Falls	ID	Pinecrest Muni. G.C.	48	X	X	X	X
AS44	Idaho Falls	ID	Curley Park	42				
AS45	Idaho Falls	ID	Rose Hill Cemetery	37				
AS46	Pocatello	ID	Alameda Park	39				
AS47	Pocatello	ID	Raymond Park	51				
AS48	Pocatello	ID	Mt. View Cemetery	44				
AS49	Pocatello	ID	Memorial Park	51				
AS50	Pocatello	ID	Caldwell Park	57	X	X	X	X
BA01	Seattle	WA	Volunteer Park	51				
BA02	Seattle	WA	Woodland Park	72	X			
BA03	Seattle	WA	Wash. Park Arboretum	52	X	X	X	X
BA04	Seattle	WA	Leschi Park	43				
BA05	Seattle	WA	Seward Park	25				
BA06	Seattle	WA	Lincoln Park	52				
BA07	Seattle	WA	Lincoln Park	--				
BA08	Medford	OR	McLoughlin Jr. H.S.	36				
BA09	Medford	OR	Medford H.S.	30	X			
BA10	Medford	OR	private lawn	33				
BA11	Medford	OR	Hawthorne Park	39	X	X	X	X
BA12	Medford	OR	private lawn	--				
BA13	San Francisco	CA	Alta Plaza Park	24	X	X		
BA14	San Francisco	CA	Jefferson Square	--				

BA15	San Francisco	CA	Mission Dolores Park	23	X X X X
BA16	San Francisco	CA	Garfield Square	18	
BA17	San Francisco	CA	Franklin Square	24	
BA18	Long Beach	CA	Recreation Park	23	X X
BA19	Long Beach	CA	Bixby Park	17	
BA20	Long Beach	CA	Bluff Park	16	X
BA21	Los Angeles	CA	Griffith Park G.C.	--	
BA22	Los Angeles	CA	Griffith Park G.C.	--	
BA23	Los Angeles	CA	Griffith Park P.A.	--	
BA24	Los Angeles	CA	Rancho Park	--	
BA25	Los Angeles	CA	Holmby Park	21	
BA26	Los Angeles	CA	Dickson Plaza, UCLA	--	
BA27	Los Angeles	CA	Dickson Plaza, UCLA	--	
BA28	Los Angeles	CA	Brand Park	--	
BA29	Los Angeles	CA	N. Hollywood Park	21	X X X X
BA30	Los Angeles	CA	Reseda Park	16	X X X X
BA31	Los Angeles	CA	Lincoln Park	16	
BA32	Los Angeles	CA	MacArthur Park	--	
BA33	Los Angeles	CA	Lafayette Park	26	
BE01	Furnace Creek	CA	private ranch	21	X X X X
BE02	Furnace Creek	CA	golf course	--	
BE03	Beatty	NV	private lawn	23	X
BE04	Pahrump	NV	private lawn	--	
BE05	Pahrump	NV	private lawn	--	
BE05A	Pahrump	NV	desert SE of town	35	
BE06	Shoshone	CA	private lawn	27	X X
BE07	Shoshone	CA	marsh area	--	
BE08	Tecopa	CA	field N of town	30	X
BE09	Bullhead City	AZ	Davis Camp Park	28	X X
BE10	Indian Springs	NV	private lawn	32	X X X X
BE11-19 not used					
BE20	Big Pine	CA	private lawn	--	
BE21	Big Pine	CA	Unified School	19	X
BE22	Bishop	CA	Bishop High School	21	X X X X
BE23	Bishop	CA	private lawn	20	X
BE24	Bishop	CA	private lawn	--	
BE25	Independence	CA	County Courthouse	17	X X
BE26	Lone Pine	CA	high school	18	X
BE27	Lone Pine	CA	Inyo Elem. School	20	X
BE28	Ridgecrest	CA	Ridgecrest City Park	3	X
BE29	China Lake	CA	Murray Junior High	12	X X
BE30	Inyokern	CA	Inyokern Park	16	X
BE31	Beatty	NV	private pasture	--	
BE32	Beatty	NV	private pasture	40	X X X X
BE33	Carver's	NV	private ranch	--	
BE34A	Carver's	NV	private ranch	16	
BE34B	Carver's	NV	private ranch	37	X X
BE35	Moapa	NV	private lawn	7	
BE36	Glendale	NV	private lawn	?	
BE37	Alamo	NV	private lawn	?	X X X X

BE38	Alamo	NV	private lawn	?	X	X		
BE39	Alamo	NV	private lawn	?	X	X		
BE40	Alamo	NV	private property	?	X	X		
BF01	Bluebell	UT	private lawn	50	X	X		
BF02	Bluebell	UT	private lawn	--				
BF03	Arcadia	UT	private lawn	48	X	X	X	X
BF04	Arcadia	UT	private lawn	--				
BF05	Altonah	UT	private lawn	41	X	X	X	X
BF06	Altonah	UT	private farm	73	X			
BF07	Altonah	UT	private lawn	--				
BF08	Altonah	UT	private pasture	36	X			
BF09	Altonah	UT	private lawn	57	X	X		
BF10	Duchesne	UT	private farm	40	X	X	X	X
BF11	Riverton	WY	Old Riverton H.S.	--	X			
BF12	Riverton	WY	private lawn	--				
BF13	Riverton	WY	private lawn	35	X	X	X	X
BF14	Rawlins	WY	St. Joseph Rectory	52	X			
BF15	Rawlins	WY	private lawn	41	X	X	X	X
BF16	Rawlins	WY	Penitentary	32				
BF17	Upalco	UT	private lawn	51	X			
BF18	Upalco	UT	private pasture	51	X			
BF19	Upalco	UT	private lawn	45	X	X	X	X
BF20	Upalco	UT	private lawn	27	X			
BF21	Bluebell	UT	private lawn	32	X			
BF22	Bluebell	UT	private lawn	39	X	X		
BF23	Bluebell	UT	private pasture	34	X			
BF24	Bluebell	UT	private yard	39	X			
BF25	Altamont	UT	private lawn	31	X			
BF26	Altonah	UT	private lawn	--				
BF27	Mountain Home	UT	private lawn	43	X			
BF28	Mountain Home	UT	private lawn	51	X			
BF29	Mountain Home	UT	private lawn	35				
BF30	Talmage	UT	private field	38	X			
BF31	Talmage	UT	private pasture	40	X			
BF32	Talmage	UT	private pasture	57	X			
BF33	Talmage	UT	private hayfield	4				
DZ01	Baker	NV	Ranger Station	52	X	X	X	X
DZ02	Baker	NV	Lehman Caves	--				
DZ03	Ely	NV	City Park	--				
DZ03A	Ely	NV	County Courthouse	30	X			
DZ04	Ely	NV	Ranger Station	62	X	X	X	X
DZ04A	Ely	NV	Ranger Station	99	X	X		
DZ05	Ely	NV	across from H.S.	--				
DZ05A	Ely	NV	across from library	42	X	X	X	X
DZ06	Ely	NV	private pasture	--				
DZ07	Ely	NV	Cemetery	40	X			
DZ08	McGill	NV	private lawn	--				
DZ09	McGill	NV	private lawn	--				
DZ09A	McGill	NV	private lawn	86	X	X	X	X
DZ10	Ibapah	UT	private pasture	108	X	X	X	X

DZ11	Ibapah	UT	private pasture	80	X			
DZ12	Callao	UT	private ranch	66	X			
DZ13	Spring Valley	NV	private ranch	--				
DZ14	Spring Valley	NV	private pasture	48	X			
DZ15	Lages Station	NV	private lawn	58	X			
DZ16	Wendover	UT	private lawn	45	X	X	X	X
DZ17	Tooele	UT	City Hall	58				
DZ18	Tooele	UT	Tooele School	46	X	X	X	X
DZ19	Tooele	UT	Cemetery	64	X			
DZ20	Dugway	UT	private pasture	119	X			
DZ21	Iosepa	UT	private pasture	53	X	X	X	X
EML3	St. George	UT	Old park	40	X	X	X	X
E20A	Kanab	UT	private lawn	46	X	X	X	X
E26A	Parowan	UT	private lawn	46	X	X	X	X
E35	Cedar City	UT	Railroad Station	32	X	X	X	X
E132	Vernal	UT	Central Elem. School	37	X	X	X	X
FM01	Kingman	AZ	County Courthouse	41	X	X	X	X
FM02	Kingman	AZ	Metcalf Park	22	X			
FM03	Valentine	AZ	private ranch	13				
FM04	Valentine	AZ	private ranch	43	X			
FM05	Peach Springs	AZ	open range	51	X			
FM06	Seligman	AZ	private ranch	57	X			
FM07	GCNP, S. Rim	AZ	Hopi Tower	115	X			
FM08	GCNP, S. Rim	AZ	Railroad siding	54	X	X	X	X
FM09	GCNP, S. Rim	AZ	Clinic	107	X			
FM10	GCNP, S. Rim	AZ	Grandview Tower Rd.	82	X	X		
FM11	GCNP, S. Rim	AZ	Buggeln Hills P. A.	99	X			
FM12	GCNP, S. Rim	AZ	Tusayan ruin	95	X			
FM13	Tuba City	AZ	T.C. Recovery Center	14				
FM14	Tuba City	AZ	private lawn	23	X	X	X	X
FM15	Window Rock	AZ	BIA Admin. Building	11				
FM16	Gallup	NM	Courthouse	35	X	X	X	X
FM17	Holbrook	AZ	old courthouse	25	X	X	X	X
FM17A	Joseph City	AZ	private lawn	32	X			
FM18	Crystal	NM	Washington Pass	90	X			
FM19	Crystal	NM	Mountain meadow	62	X			
FM20	Crystal	NM	Wash. Pass summit	--				
FM21	Winslow	AZ	Sante Fe RR office	29				
FM22	Winslow	AZ	Sante Fe RR office	13				
FM23	Winslow	AZ	Sante Fe RR office	18				
FM24	Winslow	AZ	Sante Fe RR office	16				
FM25	Ganado	AZ	Nurse's home	21				
FM26	Ganado	AZ	Ganado College Park	29	X			
FM27	Ganado	AZ	Summit House	--				
FM28	Ganado	AZ	behind Summit House	--				
FM29	Ganado	AZ	Coll. Admin. Bldg.	39	X	X	X	X
FM30	Albuquerque	NM	Soldier/Sailor Park	35				
FM31	Albuquerque	NM	Albuquerque Zoo	41	X	X	X	X
FM32	Albuquerque	NM	Rio Grande Park	35	X	X	X	
FM33	Albuquerque	NM	Bataan Park	49	X	X	X	X

FM34	Albuquerque	NM	McLellan Park	46	X	X	X	
FM35	Albuquerque	NM	Roosevelt Park	48	X	X	X	X
FM36	Lukachakai	AZ	along road	--				
FM37	Lukachakai	AZ	along road	--				
FM38	Lukachakai	AZ	along road	--				
FM39	Chinle	AZ	Garcia Trading Post	35	X	X	X	X
FM40	Sawmill	AZ	natural grassland	70	X			
FM41	Navajo Mt.	AZ	cleared area	--				
FM42	Williams	AZ	private property	66	X			
FM43	Williams	AZ	private lawn	77	X	X	X	X
FM44	Williams	AZ	church lawn	80	X			
FM45	Flagstaff	AZ	Railway Station	36	X	X	X	X
FM46	Flagstaff	AZ	private lawn	108	X	X	X	X
FM47	Flagstaff	AZ	Citizens Cemetery	59	X			
FM48	Flagstaff	AZ	North. Arizona Univ.	39				
FM49	Flagstaff	AZ	private ranch	68	X			
FM50	Flagstaff	AZ	private lawn	75	X	X	X	
FM51	Flagstaff	AZ	private lawn	34	X			
FM52	Fort Defiance	AZ	Hospital lawn	43	X			
FM53	Fort Defiance	AZ	across from hospital	30				
FM54	Fort Defiance	AZ	BIA Park	32	X	X		
FM55	GCNP, S. Rim	AZ	Desert View junction	70	X			
GC01	Reno	NV	UNR Quad	28	X			
GC02	Reno	NV	Reno High School	34	X			
GC03	Sparks	NV	Sparks Jr. H. S.	--				
GC04	Reno	NV	private pasture	44	X			
GC05	Reno	NV	Virginia Lake Park	35	X	X	X	X
GC06	Reno	NV	Whitacre Park	30	X	X	X	X
GC07	Reno	NV	Pickett Park	27	X			
GC08	Gerlach	NV	private lawn	35	X	X	X	X
GC09	Gerlach	NV	saltgrass meadow	19				
GC10	Lovelock	NV	County Courthouse	30	X	X		
GC11	Lovelock	NV	Elementary school	--				
GC12	Lovelock	NV	High School	54	X	X	X	X
GC13	Fallon	NV	City Hall	24	X			
GC14	Fallon	NV	Old Post Office	24				
GC15	Fallon	NV	County Hospital	29	X	X	X	X
GC16	Gabbs	NV	private lawn	27				
GC17	Gabbs	NV	private lawn	30	X			
GC18	Gabbs	NV	private lawn	--				
GC19	Gabbs	NV	private lawn	36	X	X	X	X
GC20	Austin	NV	private lawn	59	X	X	X	X
GC21	Austin	NV	Cahill Sprg. meadow	207	X			
GC22	Austin	NV	Wolf Meadows	145	X			
GC23	Austin	NV	Bob Scott Spring	92	X	X	X	X
GC24	Round Mountain	NV	private pasture	64	X			
GC25	Round Mountain	NV	private pasture	--				
GC26	Tom's Place	CA	private lawn	39	X			
GC27	Tom's Place	CA	meadow	34	X			
GC28	Tom's Place	CA	meadow 2 miles north	--				

GC29	Bridgeport	CA	County Courthouse	38	X	X	X	
GC30	Bridgeport	CA	private lawn	38				
GC31	Bridgeport	CA	private lawn	--				
GC32	Hawthorne	NV	AAD Parade Ground	30				
GC33	Hawthorne	NV	AAD Officer's Qtrs.	39	X	X	X	X
GC34	Hawthorne	NV	AAD Sr. Off. Qtrs.	24				
GC35	Hawthorne	NV	School Dist. office	29				
GC36	Hawthorne	NV	6th Street School	31	X			
GC37	Hawthorne	NV	private lawn	--				
GC38	Yerington	NV	County Courthouse	18				
GC39	Yerington	NV	Swimming Pool Park	26	X	X		
GC40	Yerington	NV	old county maint. yard	18	X			
GC41	Minden	NV	County Courthouse	15				
GC42	Minden	NV	School District HQ	21	X			
GC43	Gardnerville	NV	Junior High School	24	X	X		
GC44	Gardnerville	NV	Elementary School	26	X			
GC45	Carson City	NV	Nye Building	32	X			
GC46	Carson City	NV	Supreme Court	22	X			
GC47	Carson City	NV	State Library	29	X			
GC48	Carson City	NV	Hospital lawn	36	X	X	X	X
GC49	Warm Springs	NV	private ranch	--				
GC49A	Warm Springs	NV	private ranch	58	X			
GC50	Moore's Station	NV	orchard	51	X	X	X	X
KM01	Memphis	TN	Overton Park	64	X	X		
KM02	Memphis	TN	Winchester North Park	--				
KM03	Memphis	TN	Confederate Park	--				
KM04	Memphis	TN	Pine Hill Park	62				
KM05	Memphis	TN	Charjean Park	70				
KM06	Memphis	TN	Audubon Park	75	X	X	X	X
KM07	Memphis	TN	Gaisman Park	61				
KM08	Memphis	TN	Douglass Park	63				
KM09	Dallas	TX	Kiest Park	77				
KM10	Dallas	TX	Stevens Park	57				
KM11	Dallas	TX	Lake Cliff Park	46	X			
KM12	Dallas	TX	Lee Park	--				
KM13	Dallas	TX	Bachman Lake Park	57	X	X	X	X
KM14	Dallas	TX	Churchill Park	27				
KM15	Dallas	TX	White Rock Lake Park	--				
KM16	Dallas	TX	Fair Park	--				
KM17	Dallas	TX	S. Methodist Univ.	11				
KM18	Corpus Christi	TX	Del Mar College E.	47	X	X	X	
KM19	Corpus Christi	TX	Del Mar College W.	15				
KM20	Corpus Christi	TX	Blucher Park	31				
KM21	Corpus Christi	TX	Garza Park	36	X	X	X	X
KM22	Corpus Christi	TX	Wiggins Park	--				
KM23	Corpus Christi	TX	Oak Park	--				
KM24	Corpus Christi	TX	Bill Witt Park	33				
KM25	Corpus Christi	TX	Oso Golf Course	13				
KM26	Tucson	AZ	U. of Arizona	--				
KM27	Tucson	AZ	Gene Reid Park	19				

KM28	Tucson	AZ	Alvina Himmel Park	36	X	X	X	X
KM29	Tucson	AZ	LaMadera Park	28	X	X		
KM30	Tucson	AZ	DeAnza Park	51	X			
KM31	Tucson	AZ	Santa Rita Park	25				
KM32	Tucson	AZ	Rodeo Park	8				
KM33	Tucson	AZ	Mission Park	26	X	X	X	X
KM34	Tucson	AZ	Menlo Park	42	X			
KS01	Fredonia	AZ	Elementary school	36	X	X	X	X
KS02	Fredonia	AZ	private lawn	35				
KS03	Fredonia	AZ	private lawn	35				
KS04	Fredonia	AZ	private lawn	--				
KS05	GCNP, N. Rim	AZ	Lodge	126	X	X		
KS06	GCNP, N. Rim	AZ	meadow	27				
KS07	Moccasin	AZ	private lawn	41	X	X	X	X
KS08	Moccasin	AZ	private lawn	--				
KS09	Dry Park	AZ	meadow	118	X			
KS09A	Dry Park	AZ	meadow	?	X			
KS10	GCNP, N. Rim	AZ	Entrance Station	196	X	X	X	X
KS11	Demotte Park	AZ	meadow	116	X			
KS12	Big Spring	AZ	meadow near R.S.	89	X			
KS12A	Big Spring	AZ	meadow near R.S.	?	X			
KS13	Big Spring	AZ	Ranger Station	30	X			
KS14	Jacobs Lake	AZ	meadow	103	X			
KS15	Tuweep	AZ	pasture	32	X			
KS16	Tuweep	AZ	grassy field	67	X			
KS17	Mt. Trumbull	AZ	field 9 miles east	46	X			
KS18	Mt. Trumbull	AZ	field 6 miles east	--				
KS19	Wolf Hole	AZ	meadow	25				
KS20	Littlefield	AZ	Post Office	47	X			
KS21	Littlefield	AZ	private lawn	52	X	X	X	X
KS22	Mesquite	NV	private lawn	32				
KS23	Mesquite	NV	private lawn	24				
KS24	Mesquite	NV	private lawn	43	X	X	X	X
KS25	Bunkerville	NV	private lawn	63	X	X	X	X
KS26	Bunkerville	NV	private lawn	78	X	X	X	X
KS27	Logandale	NV	private lawn	15	X	X		
KS28	Logandale	NV	church lawn	8				
KS29	Overton	NV	private lawn	26	X			
KS30	Overton	NV	church lawn	34	X	X	X	X
KS31	Warm Springs	NV	private yard	25	X			
KS32	Alamo	NV	Pahranagat NWR	36	X			
KS33	Alamo	NV	private lawn	26	X	X	X	X
KS34	Alamo	NV	private lawn	18	X	X		
KS35	Alamo	NV	private lawn	--				
KS36	Hiko	NV	Pittman WMA Office	35	X	X	X	X
KS37	Hiko	NV	Post Office	20	X			
MH01	Rosette	UT	private pasture	81				
MH02	Rosette	UT	private hayfield	82	X	X	X	X
MH03	Snowville	UT	cemetery	189	X	X	X	X
MH04	Snowville	UT	meadow	149				

MH05	Malad City	ID	Old high school	53				
MH06	Malad City	ID	Pioneer Park	50				
MH07	Malad City	ID	church lawn	54	X	X	X	X
MH08	Malad City	ID	City Park	--				
MH09	Malad City	ID	private pasture	68	X			
MH10	Burley	ID	cemetery	34				
MH11	Burley	ID	Burley Baseball Park	38	X	X		
MH12A	Burley	ID	Municipal Airport	120	X	X	X	X
MH12B	Burley	ID	Municipal Airport	93				
MH12C	Burley	ID	Municipal Airport	105				
MH12D	Burley	ID	Municipal Airport	123				
MH12E	Burley	ID	Municipal Airport	139	X			
MH13	Burley	ID	County Fairgrounds	53				
MH14	Twin Falls	ID	County Courthouse	40	X	X	X	X
MH15	Twin Falls	ID	Sunset Memorial Park	36				
MH16	Twin Falls	ID	pasture	33				
MH17	Filer	ID	County Fairgrounds	34	X	X	X	X
MH18	Twin Falls	ID	private pasture	37				
MH19	Meridian	ID	M. Intermed. School	43	X	X	X	X
MH20	Boise	ID	pasture	--				
MH21	Boise	ID	Julia Davis Park	41				
MH22	Boise	ID	State Capitol	73	X	X	X	X
MH23	Boise	ID	VA Hospital	37				
MH24	Boise	ID	private pasture	--				
MH25	Jordan Valley	OR	Union High School	66	X	X		
MH26	Jordan Valley	OR	private pasture	63				
MH27	Burns	OR	Experiment Station	73	X			
MH28	Hines	OR	private lawn	43	X	X	X	X
MH29	Basque Station	OR	Hwy. Maint. Station	36	X	X	X	X
MH30	McDermitt	NV	private ranch	--				
MH31	Winnemucca	NV	private lawn	42				
RB01	Scottsbluff	NB	Riverside Park	55	X	X	X	X
RB02	Scottsbluff	NB	Overland Park	45				
RB03	Scottsbluff	NB	Public Library	--				
RB04	Scottsbluff	NB	Band Park	45				
RB05	Scottsbluff	NB	Pioneer Park	46	X			
RB06	Scottsbluff	NB	cemetery	--				
RB07	Rapid City	SD	Dinosaur Park	--				
RB08	Rapid City	SD	Halley Park	66	X	X	X	X
RB09	Rapid City	SD	Mountainview Cem.	113	X			
RB10	Rapid City	SD	Lime Creek	11				
RB11	Rapid City	SD	church lawn	134	X	X		
RB12	Rapid City	SD	Wilderness Park	--				
RB13	Billings	MT	South Park	57	X			
RB14	Billings	MT	Highland Park	42				
RB15	Billings	MT	Terry Park	49				
RB16	Billings	MT	Pioneer Park	59	X	X	X	X
RB17	Billings	MT	Swords Park	--				
RM01	Winnemucca	NV	Junior High School	42				
RM02	Winnemucca	NV	Municipal Park	58	X	X	X	X

RM03	Winnemucca	NV	Post Office	29				
RM04	Winnemucca	NV	Elementary school	--				
RM05	Winnemucca	NV	Nixon Building	--				
RM06	Battle Mountain	NV	Courthouse	45	X	X	X	X
RM07	Battle Mountain	NV	private ranch	59				
RM08	Carlin	NV	Football field	83	X	X	X	X
RM09	Elko	NV	cemetery	22				
RM10	Elko	NV	city park	31	X	X	X	X
RM11	Elko	NV	High School	36				
RM12	Wells	NV	High School	62	X	X	X	X
RM13	Clover Valley	NV	private ranch	145	X			
RM14	Pioche	NV	County Courthouse	39	X	X	X	X
RM15	Pioche	NV	housing project	--				
RM15A	Pioche	NV	private field	106	X			
RM16	Pioche	NV	Masonic Cemetery	21				
RM17	Panaca	NV	private lawn	23				
RM18	Panaca	NV	meadow	41	X			
RM19	Panaca	NV	private lawn	30	X	X	X	X
RM20	Panaca	NV	school auditorium	25				
RM21	Caliente	NV	Dixon Athletic Field	37	X	X	X	X
RM22	Caliente	NV	Rose Memorial Park	32				
RM23	Alamo	NV	private ranch	59	X			
SA01	Wichita	KS	Henry Park	--				
SA02	Wichita	KS	Linwood Park	46	X	X	X	
SA03	Wichita	KS	Linwood Park	63				
SA04	Wichita	KS	Clapp Golf Course	53				
SA05	Wichita	KS	Clapp Golf Course	--				
SA06	Wichita	KS	MacDonald Park	--				
SA07	Wichita	KS	MacDonald Park	56	X	X	X	X
SA08	Wichita	KS	Fairmount Park	--				
SA09	Wichita	KS	Oak Park	47				
SA10	Wichita	KS	Cent. Riverside Park	55				
SA11	Des Moines	IA	Greenwood Park	--				
SA12	Des Moines	IA	Greenwood Park	57	X			
SA13	Des Moines	IA	Waveland Park	--				
SA14	Des Moines	IA	Waveland Park	49				
SA15	Des Moines	IA	Glendale Cemetery	--				
SA16	Des Moines	IA	Beaverdale Park	58				
SA17	Des Moines	IA	Union Park	34				
SA18	Des Moines	IA	Grandview Park	--				
SA19	Des Moines	IA	Pioneer Park	52	X	X	X	X
SA20	St. Louis	MO	Fairground Park	54	X	X	X	X
SA21	St. Louis	MO	O'Fallon Park	57				
SA22	St. Louis	MO	Sherman Park	--				
SA23	St. Louis	MO	Forest Park	49				
SA24	St. Louis	MO	Francis Park	41				
SA25	St. Louis	MO	Willmore Park	32				
SA26	St. Louis	MO	Carondelet Park	46	X	X	X	X
SA27	St. Louis	MO	Lafayette Park	--				
SA28	St. Louis	MO	Tilles Park	--				

SA29	St. Louis	MO	Faust Park	--				
SH01	Las Vegas	NV	L.V. High School	?				
SH02	Las Vegas	NV	church lawn	?				
SH03	Las Vegas	NV	private lawn	?				
SH04	Las Vegas	NV	Courthouse	?				
SH05	Las Vegas	NV	Woodland Cemetery	?	X	X		
SH06	Las Vegas	NV	private lawn	?				
SH07	N. Las Vegas	NV	Washington School	40	X	X	X	X
SH07A	N. Las Vegas	NV	Washington School	?	?			
SH07B	N. Las Vegas	NV	Kit Carson School	?	X			
SH08	N. Las Vegas	NV	Jefferson H. S.	37	X			
SH09	Henderson	NV	Soccer Field	26	X			
SH10	Henderson	NV	Morrell Park	31	X	X	X	X
SH11	Boulder City	NV	private lawn	35	X	X	X	X
SH12	Boulder City	NV	private lawn	46				
SH13	Boulder City	NV	private lawn	37				
SH14	Las Vegas	NV	Squires Park	?				
SH15	Las Vegas	NV	S. Meadows Park	?				
SW01	Lund	NV	Elementary School	--				
SW02	Lund	NV	High School	29	X	X	X	X
SW03	Preston	NV	private lawn	--				
SW03A	Preston	NV	private lawn	40	X	X	X	X
SW04	Currant	NV	private pasture	26				
SW04R	Currant	NV	private pasture	46	X			
SW05	Eureka	NV	High School	56	X	X	X	X
SW06	Duckwater	NV	private ranch	49	X	X	X	X
AQ01	Albuquerque	NM	AL Complex	56	X	X	X	X
AQ02	Albuquerque	NM	KAFB Parade Gr. SE	72	X	X	X	
AQ03	Albuquerque	NM	KAFB Parade Gr. NW	72	X	X	X	
AQ04	Albuquerque	NM	Albuquerque Zoo	47	X	X	X	X
AQ05	Albuquerque	NM	Albuquerque Zoo	47	X	X	X	
AQ06	Albuquerque	NM	Rio Grande Park	47	X	X	X	X
AQ07	Albuquerque	NM	Roosevelt Park	70	X	X	X	X
AQ08	Albuquerque	NM	Bataan Park	69	X	X	X	
AQ09	Albuquerque	NM	McClellan Park	69	X	X	X	X
AQ10	Albuquerque	NM	private lawn	76	X	X	X	
AQ11	Albuquerque	NM	Vista Sandia Sanit.	49	X	X	X	X
AQ12	Albuquerque	NM	private lawn	42	X	X	X	X
AQ13	Albuquerque	NM	church lawn	47	X	X	X	X
AQ14	Albuquerque	NM	Veteran's Hospital	50	X	X	X	X
AQ15	Albuquerque	NM	mortuary lawn	49	X	X	X	X
AQ16	Albuquerque	NM	private lawn	75	X	X	X	X
AQ17	Albuquerque	NM	Alb. Indian Hospital	49	X	X	X	X
AQ18	Albuquerque	NM	Harwood School	68	X	X	X	X
AQ19	Albuquerque	NM	Menaul School	33	X	X	X	X
AQ20	Albuquerque	NM	Sandia Mem. Gardens	39	X	X	X	X
AQ21	Albuquerque	NM	Sunset Mem. Park	28	X	X	X	X
AQ22	Albuquerque	NM	church lawn	22	X	X	X	
AQ23	Albuquerque	NM	private lawn	--	X	X	X	X
AQ24	Albuquerque	NM	K.O.C. Hall	--	X	X	X	X

AQ25	Albuquerque	NM	Job Corps Center	--	X X X X
AQ26	Albuquerque	NM	mortuary lawn	41	X X X
AQ27	Albuquerque	NM	church lawn	85	X X X X
AQ28	Albuquerque	NM	State Fairgrounds	54	X X X X
AQ29	Albuquerque	NM	church lawn	61	X X X X
AQ30	Albuquerque	NM	U. of NM, Tight Grove	25	X X X
AQ31	Albuquerque	NM	U. of NM, Pres. House	36	X X X X
AQ32	Albuquerque	NM	Memorial Hospital	45	X X X X
AQ33	Albuquerque	NM	Ridgecrest St. Merid.	48	X X X X
NM01	Estancia	NM	private lawn	51	X X
NM02	Moriarty	NM	Old Otto Airport	107	X X X X
NM03	Belen	NM	city property	38	X X X X
NM04	Las Cruces	NM	NMSU old seed house	30	X X X X
NM05	Solomonville	AZ	Sol. Elem. School	47	X X X X
NM06	Roswell	NM	Chavez Co. Courthouse	52	X X X X
NM07	Safford	AZ	City Hall	28	X X X X
NM08	Silver City	NM	Fort Bayard	61	X X X X
NM09	Socorro	NM	NMIMT, Brown Hall	35	X X X X
NM10	Carlsbad	NM	Eddy Co. Courthouse	38	X X
NM11	Portales	NM	ENMU - Admin. Building	56	X X X X
NM12	Tucumcari	NM	Quay Co. Courthouse	47	X X
NM13	Socorro	NM	NMIMT, Athletic Field	36	X X
NM14	Sante Fe	NM	SF Natl. Cemetery	67	X X
NM15	Sante Fe	NM	SF Natl. Cemetery	67	X X X X
NM16	Sante Fe	NM	U.S. Courthouse	50	X X X X
NM17	Raton	NM	Miner's Hospital	111	X X X X
NM18	Cimarron	NM	Philmont Scout Ranch	49	X X X X
NM19	Chama	NM	Little Creek Lodge	91	X X X X
NM20	Farmington	NM	private property	56	X X
NM21	Farmington	NM	private lawn	76	X X X X
NM22	Farmington	NM	private lawn	47	X X X X
NM23	Tempe	AZ	ASU Univ. Archives	23	X X
NM24	Tempe	AZ	ASU Hayden Hall	27	X X
NM25	Mesa	AZ	church lawn	35	X X X X
NM26	Litchfield Park	AZ	Cultural Arts Society	24	X X X X

APPENDIX C

Analytical Results for Each Site

APPENDIX C
Analytical Results for Each Site

The following pages list the results of the gamma-spectrometry and the plutonium analysis for each site that was analyzed. These data were used to compute the cesium and plutonium inventories in Tables 1 and 2.

Some of the gamma-counting results and nearly all of the plutonium results given here are variance-weighted averages of multiple counts of a sample bottle or platinum disk. The individual results from each separate count of every sample (including rejected results that were not used in the computations) are available for public inspection through the Coordination and Information Center at REECo: Coordination and Information Center
Reynolds Electrical and Engineering Co., Inc.
P.O. Box 98521
Las Vegas, Nevada 89193-8521
phone: (702) 295-0731
street address: 3840 South Highland Drive, Las Vegas

AF01 TALMAGE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2332	3800	3859	13489
U-238 (PCI/G)	.66	.71	.71	.63
STDEV (PCT.)	4.1	3.8	3.7	4.2
TH-232 (PCI/G)	.57	.62	.59	.64
STDEV (PCT.)	6.2	5.8	5.9	5.6
K-40 (PCI/G)	9.3	9.3	8.7	9.6
STDEV (PCT.)	2.5	2.5	2.5	2.5
CS-137 (PCI/G)	.578	.500	.200	.052
STDEV (PCT.)	2.9	3.1	5.7	18.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03923	.00678
STDEV (PCT.)	3.5	5.7

AF02 ASHLEY NATIONAL FOREST, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1324	1473	3269	7231
U-238 (PCI/G)	1.12	.74	1.13	1.34
STDEV (PCT.)	3.2	2.7	3.1	3.0
TH-232 (PCI/G)	1.34	.69	1.09	1.14
STDEV (PCT.)	3.8	4.0	4.2	4.3
K-40 (PCI/G)	14.8	7.7	12.2	14.2
STDEV (PCT.)	2.0	1.9	2.3	2.3
CS-137 (PCI/G)	3.013	3.176	.825	.036
STDEV (PCT.)	1.2	.8	2.5	30.7

**** NO PLUTONIUM ANALYSIS PERFORMED ****

AF05 TALMAGE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2272	3913	3801	14140
U-238 (PCI/G)	.73	.85	.83	.80
STDEV (PCT.)	4.0	3.4	3.4	3.5
TH-232 (PCI/G)	.69	.78	.67	.77
STDEV (PCT.)	5.5	5.0	5.5	4.9
K-40 (PCI/G)	10.8	10.6	10.7	10.5
STDEV (PCT.)	2.3	2.3	2.3	2.3
CS-137 (PCI/G)	.372	.359	.212	.094
STDEV (PCT.)	3.9	3.9	5.5	10.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02731	.00827
STDEV (PCT.)	4.0	7.2

AF14 MT. HOME, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1260	1442	3915	15566
U-238 (PCI/G)	.62	.61	.53	.54
STDEV (PCT.)	4.3	2.1	4.5	4.5
TH-232 (PCI/G)	.46	.54	.59	.53
STDEV (PCT.)	7.4	3.1	5.9	6.2
K-40 (PCI/G)	8.7	8.5	7.9	7.8
STDEV (PCT.)	2.6	1.3	2.6	2.7
CS-137 (PCI/G)	.533	.517	.404	.120
STDEV (PCT.)	3.0	1.5	3.5	8.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03180	.01269
STDEV (PCT.)	5.2	7.1

AQ01 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1873	3652	3155	13416	(694 SQ. CM.)
U-238 (PCI/G)	.79	.75	.84	.78	
STDEV (PCT.)	3.9	3.8	3.6	3.7	
TH-232 (PCI/G)	.68	.74	.77	.83	
STDEV (PCT.)	5.8	5.3	5.2	4.9	
K-40 (PCI/G)	12.9	14.0	16.1	16.3	
STDEV (PCT.)	2.2	2.0	1.9	1.8	
CS-137 (PCI/G)	.423	.384	.250	.068	
STDEV (PCT.)	3.8	4.1	5.5	15.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01981	.00385
STDEV (PCT.)	4.5	7.9

AQ02 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1744	3706	3717	13132	(694 SQ. CM.)
U-238 (PCI/G)	.92	.89	.89	.71	
STDEV (PCT.)	3.4	3.4	3.4	4.0	
TH-232 (PCI/G)	.84	.92	.90	.78	
STDEV (PCT.)	4.9	4.5	4.6	5.0	
K-40 (PCI/G)	13.0	15.8	15.7	13.6	
STDEV (PCT.)	2.2	1.9	1.9	2.1	
CS-137 (PCI/G)	.579	.349	.162	.047	
STDEV (PCT.)	3.1	4.3	7.9	22.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02101	.00491
STDEV (PCT.)	4.3	6.4

AQ03 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1295	4231	4013	14939	(694 SQ. CM.)
U-238 (PCI/G)	.91	1.05	.93	.99	
STDEV (PCT.)	3.5	3.1	3.3	3.2	
TH-232 (PCI/G)	.75	.98	.91	.92	
STDEV (PCT.)	5.4	4.4	4.6	4.7	
K-40 (PCI/G)	12.1	16.0	16.5	15.5	
STDEV (PCT.)	2.3	1.9	1.8	1.9	
CS-137 (PCI/G)	.565	.429	.137	.036	
STDEV (PCT.)	3.2	3.8	9.1	29.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02201	.00318
STDEV (PCT.)	4.6	10.2

AQ04 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2950	4572	4011	13545	(694 SQ. CM.)
U-238 (PCI/G)	.66	.65	.59	.63	
STDEV (PCT.)	4.1	4.0	4.1	4.1	
TH-232 (PCI/G)	.59	.63	.59	.57	
STDEV (PCT.)	6.3	5.7	5.8	6.2	
K-40 (PCI/G)	15.8	16.8	16.2	17.2	
STDEV (PCT.)	1.9	1.8	1.8	1.8	
CS-137 (PCI/G)	.388	.300	.085	.022	
STDEV (PCT.)	4.0	4.6	11.7	40.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04375	.00227
STDEV (PCT.)	3.8	9.4

AQ05 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2107	3544	3052	10791	(694 SQ. CM.)
U-238 (PCI/G)	.97	1.11	1.13	1.09	
STDEV (PCT.)	3.4	3.1	3.1	3.1	
TH-232 (PCI/G)	.84	.94	.99	.91	
STDEV (PCT.)	5.0	4.7	4.5	4.7	
K-40 (PCI/G)	13.2	15.5	16.6	16.0	
STDEV (PCT.)	2.2	2.0	1.9	1.9	
CS-137 (PCI/G)	.590	.300	.122	.053	
STDEV (PCT.)	3.2	5.0	10.2	20.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.09117	.00998
STDEV (PCT.)	2.9	5.2

AQ06 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1705	3968	3752	13870	(694 SQ. CM.)
U-238 (PCI/G)	.85	.92	.95	1.16	
STDEV (PCT.)	3.8	3.3	3.2	3.1	
TH-232 (PCI/G)	.60	.81	.81	.94	
STDEV (PCT.)	6.5	5.0	5.0	4.9	
K-40 (PCI/G)	11.6	16.4	17.6	16.3	
STDEV (PCT.)	2.4	1.8	1.8	2.0	
CS-137 (PCI/G)	.509	.363	.191	.066	
STDEV (PCT.)	3.5	4.1	6.5	18.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05960	.00857
STDEV (PCT.)	4.5	5.5

AQ07 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1550	3240	3686	14756	(694 SQ. CM.)
U-238 (PCI/G)	.75	.89	.92	.91	
STDEV (PCT.)	4.1	3.5	3.3	3.3	
TH-232 (PCI/G)	.68	.82	1.00	.95	
STDEV (PCT.)	5.8	5.1	4.3	4.5	
K-40 (PCI/G)	8.9	13.6	15.5	16.7	
STDEV (PCT.)	2.8	2.1	1.9	1.8	
CS-137 (PCI/G)	.575	.679	.151	.039	
STDEV (PCT.)	3.3	2.8	8.4	26.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.21397	.01005
STDEV (PCT.)	3.6	4.9

AQ08 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1406	3574	3678	15558	(694 SQ. CM.)
U-238 (PCI/G)	.76	.97	.84	.88	
STDEV (PCT.)	4.2	3.2	3.5	3.4	
TH-232 (PCI/G)	.53	.87	.91	1.02	
STDEV (PCT.)	6.9	4.9	4.6	4.2	
K-40 (PCI/G)	8.4	15.3	17.0	18.2	
STDEV (PCT.)	3.0	1.9	1.8	1.7	
CS-137 (PCI/G)	.620	.697	.178	.038	
STDEV (PCT.)	3.1	2.8	6.9	26.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.10087	.00712
STDEV (PCT.)	3.3	6.1

AQ09 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1096	2605	2838	11947	(694 SQ. CM.)
U-238 (PCI/G)	.69	.97	1.12	1.30	
STDEV (PCT.)	4.7	3.5	3.1	2.9	
TH-232 (PCI/G)	.49	.81	1.03	1.16	
STDEV (PCT.)	7.5	5.2	4.3	4.1	
K-40 (PCI/G)	9.2	13.9	16.4	18.0	
STDEV (PCT.)	2.9	2.2	1.9	1.9	
CS-137 (PCI/G)	.313	.871	.250	.051	
STDEV (PCT.)	5.1	2.5	5.9	23.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.16593	.01185
STDEV (PCT.)	3.6	4.8

AQ10 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2415	3783	3843	12630	(694 SQ. CM.)
U-238 (PCI/G)	.85	.85	.89	.95	
STDEV (PCT.)	3.7	3.6	3.4	3.5	
TH-232 (PCI/G)	.75	.79	.84	.94	
STDEV (PCT.)	5.5	5.2	4.9	4.7	
K-40 (PCI/G)	15.8	15.7	16.9	20.0	
STDEV (PCT.)	2.0	1.9	1.9	1.8	
CS-137 (PCI/G)	.408	.323	.122	.033	
STDEV (PCT.)	4.0	4.6	10.0	32.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01969	.00294
STDEV (PCT.)	4.0	8.2

AQ11 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2455	3966	4052	13226	(694 SQ. CM.)
U-238 (PCI/G)	.98	1.09	1.08	.96	
STDEV (PCT.)	3.5	3.2	3.1	3.2	
TH-232 (PCI/G)	.96	.99	1.15	1.03	
STDEV (PCT.)	4.7	4.5	4.0	4.2	
K-40 (PCI/G)	15.2	17.0	17.2	17.5	
STDEV (PCT.)	2.0	1.9	1.9	1.8	
CS-137 (PCI/G)	.484	.309	.137	.051	
STDEV (PCT.)	3.6	5.1	9.3	21.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01945	.00319
STDEV (PCT.)	4.2	8.0

AQ12 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2462	3864	3724	9118	(694 SQ. CM.)
U-238 (PCI/G)	.80	.85	.95	1.09	
STDEV (PCT.)	3.8	3.7	3.4	3.2	
TH-232 (PCI/G)	.79	.81	.90	1.05	
STDEV (PCT.)	5.2	5.2	4.8	4.4	
K-40 (PCI/G)	15.8	18.2	18.3	17.8	
STDEV (PCT.)	1.9	1.8	1.8	1.9	
CS-137 (PCI/G)	.316	.356	.212	.061	
STDEV (PCT.)	4.7	4.2	6.6	19.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01702	.00599
STDEV (PCT.)	4.1	6.3

AQ13 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2528	4327	4019	13310	(694 SQ. CM.)
U-238 (PCI/G)	.59	.52	.52	.50	
STDEV (PCT.)	4.4	4.8	4.6	4.7	
TH-232 (PCI/G)	.57	.55	.56	.49	
STDEV (PCT.)	6.2	6.5	6.3	6.8	
K-40 (PCI/G)	14.7	15.2	15.9	15.5	
STDEV (PCT.)	1.9	1.9	1.8	1.8	
CS-137 (PCI/G)	.343	.364	.226	.037	
STDEV (PCT.)	4.3	4.0	5.7	24.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01721	.00678
STDEV (PCT.)	3.9	7.6

AQ14 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2252	4275	4592	12377	(694 SQ. CM.)
U-238 (PCI/G)	.79	.82	.74	.72	
STDEV (PCT.)	3.8	3.5	3.7	3.8	
TH-232 (PCI/G)	.71	.81	.79	.75	
STDEV (PCT.)	5.4	4.9	5.0	5.1	
K-40 (PCI/G)	13.2	15.2	18.4	17.0	
STDEV (PCT.)	2.1	1.9	1.7	1.8	
CS-137 (PCI/G)	.451	.331	.149	.068	
STDEV (PCT.)	3.7	4.4	8.1	15.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01969	.00534
STDEV (PCT.)	5.3	9.5

AQ15 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1655	3283	3896	11919	(694 SQ. CM.)
U-238 (PCI/G)	.83	.80	.85	.73	
STDEV (PCT.)	3.7	3.6	3.5	3.8	
TH-232 (PCI/G)	.67	.79	.84	.85	
STDEV (PCT.)	5.8	5.0	5.0	4.7	
K-40 (PCI/G)	13.4	15.2	17.2	17.4	
STDEV (PCT.)	2.1	1.9	1.8	1.7	
CS-137 (PCI/G)	.340	.332	.262	.064	
STDEV (PCT.)	4.5	4.5	5.3	17.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01607	.00611
STDEV (PCT.)	5.6	5.5

AQ16 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1367	3950	3932	10999	(694 SQ. CM.)
U-238 (PCI/G)	1.38	.90	.86	.84	
STDEV (PCT.)	2.8	3.3	3.3	3.4	
TH-232 (PCI/G)	.56	.71	.78	.84	
STDEV (PCT.)	7.1	5.6	5.0	4.7	
K-40 (PCI/G)	11.7	18.1	19.0	20.6	
STDEV (PCT.)	2.4	1.7	1.7	1.6	
CS-137 (PCI/G)	1.149	.351	.145	.026	
STDEV (PCT.)	2.1	4.3	8.1	37.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.41946	.05100
STDEV (PCT.)	4.5	3.7

AQ17 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2659	4205	4010	11439	(694 SQ. CM.)
U-238 (PCI/G)	.77	.78	.75	.71	
STDEV (PCT.)	3.8	3.6	3.7	3.8	
TH-232 (PCI/G)	.78	.72	.71	.76	
STDEV (PCT.)	5.1	5.3	5.3	5.1	
K-40 (PCI/G)	13.8	15.4	15.9	17.0	
STDEV (PCT.)	2.1	1.9	1.8	1.7	
CS-137 (PCI/G)	.473	.281	.115	.012	
STDEV (PCT.)	3.5	5.0	9.5	80.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01840	.00242
STDEV (PCT.)	4.5	9.8

AQ18 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2067	4054	4308	14593	(694 SQ. CM.)
U-238 (PCI/G)	.75	.77	.71	.74	
STDEV (PCT.)	4.0	3.7	3.8	3.6	
TH-232 (PCI/G)	.56	.66	.70	.74	
STDEV (PCT.)	6.6	5.7	5.4	5.0	
K-40 (PCI/G)	13.8	16.6	17.2	17.3	
STDEV (PCT.)	2.1	1.8	1.8	1.8	
CS-137 (PCI/G)	.781	.290	.113	.016	
STDEV (PCT.)	2.6	4.7	9.7	60.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02050	.00342
STDEV (PCT.)	4.3	8.2

AQ19 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2389	4155	4574	15416	(694 SQ. CM.)
U-238 (PCI/G)	.80	.81	.80	.76	
STDEV (PCT.)	3.8	3.7	3.7	3.8	
TH-232 (PCI/G)	.77	.82	.83	.94	
STDEV (PCT.)	5.2	5.0	5.0	4.5	
K-40 (PCI/G)	16.1	19.2	19.6	20.2	
STDEV (PCT.)	1.9	1.7	1.6	1.6	
CS-137 (PCI/G)	.374	.330	.253	.099	
STDEV (PCT.)	4.2	4.6	5.5	11.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01692	.00785
STDEV (PCT.)	5.1	5.3

AQ20 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2260	3880	3900	15053	(694 SQ. CM.)
U-238 (PCI/G)	.69	.63	.75	.68	
STDEV (PCT.)	4.0	4.2	3.7	4.1	
TH-232 (PCI/G)	.65	.72	.76	.77	
STDEV (PCT.)	5.8	5.3	5.2	5.2	
K-40 (PCI/G)	14.6	15.4	17.1	18.4	
STDEV (PCT.)	2.0	1.9	1.8	1.7	
CS-137 (PCI/G)	.325	.316	.200	.037	
STDEV (PCT.)	4.5	4.6	6.7	28.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01678	.00398
STDEV (PCT.)	4.7	8.4

AQ21 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2333	4245	3659	14801	(694 SQ. CM.)
U-238 (PCI/G)	.90	.95	.96	.98	
STDEV (PCT.)	3.5	3.4	3.3	3.2	
TH-232 (PCI/G)	.86	.93	1.14	1.10	
STDEV (PCT.)	5.0	4.7	4.0	4.1	
K-40 (PCI/G)	17.2	19.3	19.5	19.9	
STDEV (PCT.)	1.8	1.7	1.7	1.7	
CS-137 (PCI/G)	.239	.227	.210	.106	
STDEV (PCT.)	6.0	6.1	6.6	11.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01144	.00626
STDEV (PCT.)	4.6	5.9

AQ22 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2863	4462	3897	14323	(694 SQ. CM.)
U-238 (PCI/G)	.80	.82	.81	.66	
STDEV (PCT.)	3.6	3.5	3.5	4.1	
TH-232 (PCI/G)	.93	.86	.91	.79	
STDEV (PCT.)	4.4	4.7	4.5	4.9	
K-40 (PCI/G)	18.7	19.7	17.9	17.1	
STDEV (PCT.)	1.7	1.6	1.7	1.8	
CS-137 (PCI/G)	.175	.137	.063	.008	
STDEV (PCT.)	7.4	9.2	17.1	116.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.00853	.00124
STDEV (PCT.)	5.3	13.7

AQ23 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2282	4048	3647	13633	(694 SQ. CM.)
U-238 (PCI/G)	.75	.75	.76	.73	
STDEV (PCT.)	3.8	3.8	3.6	3.7	
TH-232 (PCI/G)	.69	.71	.80	.81	
STDEV (PCT.)	5.6	5.4	4.9	4.8	
K-40 (PCI/G)	15.7	17.6	18.3	19.5	
STDEV (PCT.)	1.9	1.8	1.7	1.6	
CS-137 (PCI/G)	.905	.279	.065	.010	
STDEV (PCT.)	2.3	5.0	16.6	99.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02579	.00310
STDEV (PCT.)	4.8	12.1

AQ24 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2072	4119	3852	8533	(694 SQ. CM.)
U-238 (PCI/G)	.82	.85	.80	.75	
STDEV (PCT.)	3.7	3.4	3.7	3.9	
TH-232 (PCI/G)	.72	.84	.88	.84	
STDEV (PCT.)	5.4	4.9	4.8	4.8	
K-40 (PCI/G)	15.1	16.4	17.5	17.9	
STDEV (PCT.)	2.0	1.8	1.8	1.8	
CS-137 (PCI/G)	.431	.321	.146	.064	
STDEV (PCT.)	3.9	4.5	8.6	17.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02433	.00495
STDEV (PCT.)	4.7	7.7

AQ25 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1869	4603	3755	11820	(694 SQ. CM.)
U-238 (PCI/G)	.81	.90	.99	.99	
STDEV (PCT.)	3.8	3.5	3.2	3.3	
TH-232 (PCI/G)	.78	.86	.90	.92	
STDEV (PCT.)	5.1	4.9	4.7	4.6	
K-40 (PCI/G)	16.3	18.6	19.1	19.3	
STDEV (PCT.)	1.9	1.8	1.7	1.7	
CS-137 (PCI/G)	.162	.188	.226	.100	
STDEV (PCT.)	7.7	6.9	6.2	12.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03226	.02211
STDEV (PCT.)	4.3	4.7

AQ26 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1438	3352	3482	14791	(694 SQ. CM.)
U-238 (PCI/G)	.75	.89	.88	.81	
STDEV (PCT.)	3.9	3.4	3.5	3.5	
TH-232 (PCI/G)	.76	.80	.84	.91	
STDEV (PCT.)	5.2	5.0	4.9	4.5	
K-40 (PCI/G)	14.1	16.3	17.7	18.4	
STDEV (PCT.)	2.1	1.9	1.8	1.7	
CS-137 (PCI/G)	.340	.366	.282	.088	
STDEV (PCT.)	4.5	4.1	5.0	12.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01615	.00671
STDEV (PCT.)	4.7	5.3

AQ27 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1073	4233	4111	15771	(694 SQ. CM.)
U-238 (PCI/G)	.76	.86	.73	.85	
STDEV (PCT.)	4.2	3.6	4.0	3.4	
TH-232 (PCI/G)	.60	.83	.88	.97	
STDEV (PCT.)	6.5	5.1	4.7	4.3	
K-40 (PCI/G)	11.1	17.0	17.2	16.7	
STDEV (PCT.)	2.5	1.8	1.8	1.8	
CS-137 (PCI/G)	1.277	.525	.064	.007	
STDEV (PCT.)	2.0	3.3	17.4	149.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02856	.00156
STDEV (PCT.)	4.7	13.7

AQ28 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2202	3929	3206	12818	(694 SQ. CM.)
U-238 (PCI/G)	.85	.81	.84	.78	
STDEV (PCT.)	3.6	3.6	3.5	3.7	
TH-232 (PCI/G)	.72	.81	.83	.88	
STDEV (PCT.)	5.6	4.9	4.8	4.6	
K-40 (PCI/G)	13.0	15.5	16.5	17.3	
STDEV (PCT.)	2.2	1.9	1.8	1.8	
CS-137 (PCI/G)	.569	.510	.239	.057	
STDEV (PCT.)	3.2	3.3	5.7	19.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02171	.00472
STDEV (PCT.)	4.4	8.4

AQ29 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1845	3747	3972	14229	(694 SQ. CM.)
U-238 (PCI/G)	.81	.95	1.02	.95	
STDEV (PCT.)	3.8	3.3	3.0	3.3	
TH-232 (PCI/G)	.70	.84	.86	.98	
STDEV (PCT.)	5.8	4.9	4.7	4.4	
K-40 (PCI/G)	13.2	16.0	16.3	18.4	
STDEV (PCT.)	2.2	1.9	1.8	1.7	
CS-137 (PCI/G)	.853	.375	.124	.023	
STDEV (PCT.)	2.5	4.2	9.7	47.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02487	.00301
STDEV (PCT.)	5.2	9.0

AQ30 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2311	3189	3875	13444	(694 SQ. CM.)
U-238 (PCI/G)	.91	.78	.93	.98	
STDEV (PCT.)	3.4	3.6	3.2	3.2	
TH-232 (PCI/G)	.75	.75	.93	.99	
STDEV (PCT.)	5.3	5.2	4.4	4.3	
K-40 (PCI/G)	13.7	14.8	16.0	16.1	
STDEV (PCT.)	2.1	1.9	1.8	1.9	
CS-137 (PCI/G)	.179	.115	.082	.030	
STDEV (PCT.)	7.2	9.9	14.1	36.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.00750	.00242
STDEV (PCT.)	10.0	12.4

AQ31 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1989	3521	3143	14091	(694 SQ. CM.)
U-238 (PCI/G)	.75	.88	.73	.73	
STDEV (PCT.)	3.8	3.2	3.8	3.8	
TH-232 (PCI/G)	.70	.23	.79	.88	
STDEV (PCT.)	5.5	8.1	5.0	4.5	
K-40 (PCI/G)	13.7	14.4	16.1	16.3	
STDEV (PCT.)	2.1	2.0	1.8	1.9	
CS-137 (PCI/G)	.334	.321	.222	.076	
STDEV (PCT.)	4.4	4.5	5.9	14.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01715	.01062
STDEV (PCT.)	5.3	7.4

AQ32 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1820	3582	3514	12426	(694 SQ. CM.)
U-238 (PCI/G)	.70	.72	.86	.76	
STDEV (PCT.)	4.0	4.0	3.5	3.8	
TH-232 (PCI/G)	.73	.76	.86	.88	
STDEV (PCT.)	5.3	5.3	4.8	4.7	
K-40 (PCI/G)	14.8	17.5	17.8	17.9	
STDEV (PCT.)	2.0	1.8	1.8	1.8	
CS-137 (PCI/G)	.419	.435	.217	.032	
STDEV (PCT.)	3.9	3.7	6.0	32.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02050	.00377
STDEV (PCT.)	5.1	9.8

AQ33 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1028	2308	3901	14698	(694 SQ. CM.)
U-238 (PCI/G)	.76	.93	.90	.79	
STDEV (PCT.)	4.4	3.6	3.3	3.8	
TH-232 (PCI/G)	.55	.77	.95	.86	
STDEV (PCT.)	6.9	5.4	4.5	4.8	
K-40 (PCI/G)	7.6	12.1	18.7	16.5	
STDEV (PCT.)	3.2	2.3	1.7	1.9	
CS-137 (PCI/G)	.351	1.159	.181	.050	
STDEV (PCT.)	4.7	2.1	7.2	21.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.14778	.00969
STDEV (PCT.)	4.6	6.6

AS01 FARMINGTON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2603	4831	4848	16725	(694 SQ. CM.)
U-238 (PCI/G)	.94	.75	.87	.77	
STDEV (PCT.)	1.6	2.7	2.4	1.8	
TH-232 (PCI/G)	.87	.78	.90	.88	
STDEV (PCT.)	2.4	3.6	3.3	2.3	
K-40 (PCI/G)	24.2	25.3	26.7	25.6	
STDEV (PCT.)	.7	1.0	1.0	.7	
CS-137 (PCI/G)	.355	.181	.232	.096	
STDEV (PCT.)	2.1	4.9	4.0	6.0	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

AS06 CORTEZ, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2871	3471	4266	14698	(694 SQ. CM.)
U-238 (PCI/G)	.99	1.10	1.07	1.16	
STDEV (PCT.)	3.3	3.0	3.1	2.9	
TH-232 (PCI/G)	.97	1.15	1.02	1.09	
STDEV (PCT.)	4.5	3.9	4.4	4.1	
K-40 (PCI/G)	17.3	16.3	16.5	17.2	
STDEV (PCT.)	1.8	1.9	1.9	1.8	
CS-137 (PCI/G)	.401	.376	.310	.094	
STDEV (PCT.)	3.8	4.0	4.7	12.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04035	.00934
STDEV (PCT.)	3.2	5.6

AS08 MANCOS, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2626	3742	3501	14409	(694 SQ. CM.)
U-238 (PCI/G)	1.23	1.27	1.28	1.27	
STDEV (PCT.)	3.0	2.9	3.0	2.9	
TH-232 (PCI/G)	1.13	1.16	1.20	1.21	
STDEV (PCT.)	4.2	4.1	4.1	3.9	
K-40 (PCI/G)	16.8	17.2	17.1	17.2	
STDEV (PCT.)	1.9	1.9	1.9	1.9	
CS-137 (PCI/G)	.595	.538	.292	.053	
STDEV (PCT.)	3.1	3.2	5.1	20.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

AS10 DURANGO, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3117	3953	4054	11926	(694 SQ. CM.)
U-238 (PCI/G)	1.95	1.94	1.72	1.57	
STDEV (PCT.)	2.2	2.2	2.4	2.4	
TH-232 (PCI/G)	.99	1.10	.91	1.06	
STDEV (PCT.)	4.7	4.3	5.0	4.2	
K-40 (PCI/G)	16.6	16.4	15.9	16.5	
STDEV (PCT.)	2.0	1.9	1.9	1.9	
CS-137 (PCI/G)	.485	.430	.249	.113	
STDEV (PCT.)	3.6	3.8	5.6	10.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02326	.00658
STDEV (PCT.)	4.0	6.2

AS13 SILVERTON, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2202	3287	1384	6322	(694 SQ. CM.)
U-238 (PCI/G)	1.54	1.61	1.63	1.56	
STDEV (PCT.)	2.7	2.5	2.7	2.6	
TH-232 (PCI/G)	1.55	1.67	1.67	1.71	
STDEV (PCT.)	3.5	3.3	3.4	3.3	
K-40 (PCI/G)	20.1	21.5	24.4	23.6	
STDEV (PCT.)	1.8	1.7	1.7	1.6	
CS-137 (PCI/G)	.958	.865	.533	.335	
STDEV (PCT.)	2.4	2.4	3.6	4.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04505	.01906
STDEV (PCT.)	3.1	4.1

AS20 MONTROSE, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2778	4077	4139	15916	(694 SQ. CM.)
U-238 (PCI/G)	1.67	1.73	1.84	1.91	
STDEV (PCT.)	2.5	2.4	2.4	1.1	
TH-232 (PCI/G)	.97	1.04	1.02	1.16	
STDEV (PCT.)	4.7	4.5	4.6	2.0	
K-40 (PCI/G)	15.4	15.9	16.5	17.5	
STDEV (PCT.)	2.1	2.0	2.0	1.0	
CS-137 (PCI/G)	.557	.296	.132	.051	
STDEV (PCT.)	3.3	5.0	9.9	12.1	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

AS21 FRUITA, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2946	4096	4291	14006	(694 SQ. CM.)
U-238 (PCI/G)	1.27	1.47	1.27	1.14	
STDEV (PCT.)	2.9	1.3	2.9	1.1	
TH-232 (PCI/G)	1.01	1.10	1.08	1.10	
STDEV (PCT.)	4.5	2.0	4.3	1.4	
K-40 (PCI/G)	16.1	16.4	16.3	16.3	
STDEV (PCT.)	2.0	1.0	2.0	.7	
CS-137 (PCI/G)	.495	.349	.162	.063	
STDEV (PCT.)	3.4	2.3	7.9	6.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02298	.00540
STDEV (PCT.)	3.7	6.1

AS26 MEEKER, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1863	3459	3346	13562	(694 SQ. CM.)
U-238 (PCI/G)	.97	1.11	1.02	1.07	
STDEV (PCT.)	3.5	3.2	3.3	2.3	
TH-232 (PCI/G)	.90	1.03	1.08	1.08	
STDEV (PCT.)	4.9	4.4	4.1	3.0	
K-40 (PCI/G)	14.5	15.3	14.8	15.8	
STDEV (PCT.)	2.1	2.1	2.1	1.4	
CS-137 (PCI/G)	.712	.695	.379	.095	
STDEV (PCT.)	2.7	2.8	4.1	9.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03905	.01008
STDEV (PCT.)	4.4	6.2

AS27 CRAIG, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2196	4100	4329	13792	(694 SQ. CM.)
U-238 (PCI/G)	1.12	1.29	1.31	1.33	
STDEV (PCT.)	3.2	3.0	2.9	2.9	
TH-232 (PCI/G)	1.13	1.24	1.38	1.36	
STDEV (PCT.)	4.4	4.1	3.7	3.8	
K-40 (PCI/G)	16.5	18.5	18.2	17.8	
STDEV (PCT.)	2.0	1.9	1.9	1.9	
CS-137 (PCI/G)	1.635	.391	.101	.035	
STDEV (PCT.)	1.7	4.3	12.1	30.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04187	.00226
STDEV (PCT.)	3.4	9.0

AS28 CRAIG, COLORADO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2715	4419	3059	13808	(694 SQ. CM.)
U-238 (PCI/G)	1.07	1.10	1.13	1.07	
STDEV (PCT.)	3.2	3.2	1.4	3.1	
TH-232 (PCI/G)	1.09	1.19	1.21	1.24	
STDEV (PCT.)	4.3	4.0	1.8	3.8	
K-40 (PCI/G)	18.0	18.6	19.0	21.3	
STDEV (PCT.)	1.8	1.8	.8	1.6	
CS-137 (PCI/G)	.812	.502	.302	.078	
STDEV (PCT.)	2.4	3.4	2.4	14.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

AS32 ROCK SPRINGS, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2421	3720	3690	12521	(694 SQ. CM.)
U-238 (PCI/G)	1.01	1.13	1.06	1.08	
STDEV (PCT.)	3.3	3.1	3.1	3.1	
TH-232 (PCI/G)	.87	.80	.91	.88	
STDEV (PCT.)	4.8	5.3	4.7	4.7	
K-40 (PCI/G)	13.3	13.4	13.3	14.6	
STDEV (PCT.)	2.1	2.2	2.1	2.0	
CS-137 (PCI/G)	.455	.405	.307	.091	
STDEV (PCT.)	3.5	3.9	4.5	11.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02750	.01105
STDEV (PCT.)	3.8	4.5

AS35 EVANSTON, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2857	4542	4268	20464	(694 SQ. CM.)
U-238 (PCI/G)	.96	.98	1.01	.85	
STDEV (PCT.)	2.3	3.3	3.1	1.6	
TH-232 (PCI/G)	.93	1.02	1.01	.85	
STDEV (PCT.)	3.2	4.3	4.3	2.2	
K-40 (PCI/G)	13.5	13.8	13.7	11.5	
STDEV (PCT.)	1.5	2.1	2.0	1.1	
CS-137 (PCI/G)	.547	.213	.119	.037	
STDEV (PCT.)	2.2	6.0	9.2	12.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01818	.00657
STDEV (PCT.)	4.5	5.6

AS36 KEMMERER, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1086	1684	4157	18005	(694 SQ. CM.)
U-238 (PCI/G)	1.06	1.09	1.04	1.19	
STDEV (PCT.)	1.7	2.3	3.3	3.0	
TH-232 (PCI/G)	.87	.91	.95	1.09	
STDEV (PCT.)	2.6	3.5	4.6	4.2	
K-40 (PCI/G)	14.0	13.4	13.9	15.3	
STDEV (PCT.)	1.1	1.6	2.1	2.0	
CS-137 (PCI/G)	2.232	.822	.124	.039	
STDEV (PCT.)	.7	1.8	9.7	26.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.06905	.00272
STDEV (PCT.)	3.3	8.5

AS41 AFTON, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2326	2775	2461	9034	(694 SQ. CM.)
U-238 (PCI/G)	1.49	1.34	1.44	1.24	
STDEV (PCT.)	2.6	2.7	2.7	2.9	
TH-232 (PCI/G)	.83	.90	.75	.81	
STDEV (PCT.)	5.3	4.9	5.7	5.1	
K-40 (PCI/G)	17.3	15.8	17.0	16.1	
STDEV (PCT.)	1.9	2.1	1.9	2.0	
CS-137 (PCI/G)	.776	.745	.401	.159	
STDEV (PCT.)	2.6	2.6	3.9	7.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04297	.01400
STDEV (PCT.)	3.5	4.6

AS43 IDAHO FALLS, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2848	4460	4779	12966	(694 SQ. CM.)
U-238 (PCI/G)	.86	.99	1.04	1.13	
STDEV (PCT.)	3.6	3.2	1.5	2.9	
TH-232 (PCI/G)	.95	1.02	1.10	1.24	
STDEV (PCT.)	4.6	4.4	2.0	3.7	
K-40 (PCI/G)	15.3	15.3	16.1	16.2	
STDEV (PCT.)	1.9	1.9	.9	1.9	
CS-137 (PCI/G)	.536	.521	.322	.052	
STDEV (PCT.)	3.1	3.1	2.3	19.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02466	.00580
STDEV (PCT.)	3.8	6.8

AS50 POCATELLO, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2648	3735	3752	14074	(694 SQ. CM.)
U-238 (PCI/G)	1.11	1.13	1.20	1.03	
STDEV (PCT.)	3.2	2.2	3.1	3.2	
TH-232 (PCI/G)	1.00	1.16	1.22	1.17	
STDEV (PCT.)	4.6	2.9	4.0	4.1	
K-40 (PCI/G)	17.2	17.3	17.6	18.1	
STDEV (PCT.)	1.9	1.3	1.9	1.8	
CS-137 (PCI/G)	.770	.629	.347	.071	
STDEV (PCT.)	2.6	2.1	4.5	15.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03308	.00728
STDEV (PCT.)	3.4	5.1

BA03 SEATTLE, WASHINGTON

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1432	3106	3039	8655	(694 SQ. CM.)
U-238 (PCI/G)	.42	.48	.49	.52	
STDEV (PCT.)	6.1	5.4	5.3	5.1	
TH-232 (PCI/G)	.30	.35	.40	.40	
STDEV (PCT.)	10.3	9.4	8.0	8.0	
K-40 (PCI/G)	7.0	7.8	8.0	8.5	
STDEV (PCT.)	3.2	2.9	2.8	2.8	
CS-137 (PCI/G)	.756	.624	.298	.082	
STDEV (PCT.)	2.6	2.9	4.6	12.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03090	.00627
STDEV (PCT.)	3.8	5.8

BA11 MEDFORD, OREGON

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1882	3397	3374	9536	(694 SQ. CM.)
U-238 (PCI/G)	.50	.63	.60	.59	
STDEV (PCT.)	5.3	4.4	4.6	4.8	
TH-232 (PCI/G)	.47	.53	.65	.53	
STDEV (PCT.)	7.6	6.7	5.7	6.7	
K-40 (PCI/G)	10.6	12.2	13.0	11.7	
STDEV (PCT.)	2.4	2.2	2.2	2.4	
CS-137 (PCI/G)	.507	.342	.108	.023	
STDEV (PCT.)	3.2	4.1	10.3	41.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02052	.00309
STDEV (PCT.)	4.3	8.8

BA13 SAN FRANCISCO, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1796	3430	3384	13433	(694 SQ. CM.)
U-238 (PCI/G)	.63	.63	.74	.71	
STDEV (PCT.)	4.1	4.2	3.7	1.9	
TH-232 (PCI/G)	.72	.75	.80	.75	
STDEV (PCT.)	5.1	5.1	4.7	2.5	
K-40 (PCI/G)	8.7	9.0	9.6	9.0	
STDEV (PCT.)	2.6	2.5	2.4	1.2	
CS-137 (PCI/G)	.320	.320	.209	.035	
STDEV (PCT.)	4.2	4.3	5.6	14.2	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BA15 SAN FRANCISCO, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2276	3900	3467	13279	(694 SQ. CM.)
U-238 (PCI/G)	.68	.65	.66	.68	
STDEV (PCT.)	4.1	4.2	4.2	2.0	
TH-232 (PCI/G)	.64	.73	.69	.75	
STDEV (PCT.)	5.7	5.2	5.5	2.5	
K-40 (PCI/G)	8.8	9.4	9.9	9.3	
STDEV (PCT.)	2.7	2.5	2.4	1.2	
CS-137 (PCI/G)	.286	.318	.163	.024	
STDEV (PCT.)	4.7	4.3	7.1	21.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01405	.00170
STDEV (PCT.)	3.8	11.8

BA18 LONG BEACH, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2769	4833	4289	15413	(694 SQ. CM.)
U-238 (PCI/G)	.78	.84	.85	.87	
STDEV (PCT.)	1.9	1.8	1.3	1.4	
TH-232 (PCI/G)	1.10	1.16	1.22	1.24	
STDEV (PCT.)	2.0	1.9	1.4	1.4	
K-40 (PCI/G)	19.6	21.4	22.6	22.1	
STDEV (PCT.)	.9	.8	.6	.6	
CS-137 (PCI/G)	.265	.168	.056	.011	
STDEV (PCT.)	2.7	3.8	7.8	37.5	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BA29 LOS ANGELES, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2380	4232	4042	14972	(694 SQ. CM.)
U-238 (PCI/G)	.52	.60	.60	.57	
STDEV (PCT.)	2.5	4.4	4.4	2.2	
TH-232 (PCI/G)	.99	1.18	1.15	1.14	
STDEV (PCT.)	2.1	3.7	3.8	1.8	
K-40 (PCI/G)	17.9	19.1	19.0	19.9	
STDEV (PCT.)	.9	1.6	1.6	.8	
CS-137 (PCI/G)	.276	.251	.122	.024	
STDEV (PCT.)	2.5	5.2	9.0	20.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01365	.00191
STDEV (PCT.)	5.6	8.5

BA30 LOS ANGELES, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2411	3870	3826	15323	(694 SQ. CM.)
U-238 (PCI/G)	1.33	1.47	1.63	1.68	
STDEV (PCT.)	1.4	2.7	1.2	1.1	
TH-232 (PCI/G)	.85	.96	1.05	1.07	
STDEV (PCT.)	2.5	4.8	2.2	2.1	
K-40 (PCI/G)	18.7	20.8	21.9	22.5	
STDEV (PCT.)	.9	1.7	.8	.8	
CS-137 (PCI/G)	.266	.199	.116	.029	
STDEV (PCT.)	2.7	6.6	5.5	19.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01090	.00209
STDEV (PCT.)	4.6	8.5

BE01 FURNACE CREEK, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2295	3836	2174	9304	(694 SQ. CM.)
U-238 (PCI/G)	.94	.97	.94	.85	
STDEV (PCT.)	3.4	3.2	3.3	3.6	
TH-232 (PCI/G)	.79	.75	.71	.60	
STDEV (PCT.)	5.1	5.2	5.5	6.1	
K-40 (PCI/G)	18.1	18.4	18.1	15.4	
STDEV (PCT.)	1.8	1.8	1.8	2.0	
CS-137 (PCI/G)	.347	.380	.320	.101	
STDEV (PCT.)	4.2	3.7	4.3	10.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02907	.01258
STDEV (PCT.)	3.9	4.7

BE06 SHOSHONE, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2844	3533	3623	10181	(694 SQ. CM.)
U-238 (PCI/G)	1.18	1.34	1.54	2.19	
STDEV (PCT.)	1.5	2.9	2.6	1.1	
TH-232 (PCI/G)	1.19	1.18	1.15	1.12	
STDEV (PCT.)	1.9	4.1	4.3	2.2	
K-40 (PCI/G)	20.2	19.4	21.7	19.3	
STDEV (PCT.)	.9	1.8	1.7	1.0	
CS-137 (PCI/G)	.254	.374	.181	.038	
STDEV (PCT.)	2.9	4.2	7.3	17.7	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE09 BULLHEAD CITY, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3145	3450	4350	20220	(694 SQ. CM.)
U-238 (PCI/G)	.69	.69	.74	.54	
STDEV (PCT.)	3.8	1.8	3.8	2.1	
TH-232 (PCI/G)	.63	.77	.95	1.22	
STDEV (PCT.)	5.7	2.4	4.4	1.5	
K-40 (PCI/G)	14.6	16.5	21.2	37.4	
STDEV (PCT.)	1.9	.9	1.6	.5	
CS-137 (PCI/G)	.278	.223	.099	.003	
STDEV (PCT.)	4.6	2.7	11.2	171.0	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE10 INDIAN SPRINGS, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1974	3513	3567	14205	(694 SQ. CM.)
U-238 (PCI/G)	1.47	1.61	1.61	1.64	
STDEV (PCT.)	2.7	2.5	2.5	1.1	
TH-232 (PCI/G)	.61	.73	.73	.70	
STDEV (PCT.)	6.5	5.6	5.6	2.8	
K-40 (PCI/G)	10.6	11.4	11.4	11.0	
STDEV (PCT.)	2.6	2.4	2.4	1.1	
CS-137 (PCI/G)	.433	.323	.120	.031	
STDEV (PCT.)	3.8	4.5	9.8	17.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05748	.00744
STDEV (PCT.)	4.8	5.9

BE22 BISHOP, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2518	3317	3882	16155	(694 SQ. CM.)
U-238 (PCI/G)	1.28	1.27	1.14	1.16	
STDEV (PCT.)	1.3	1.0	2.9	1.1	
TH-232 (PCI/G)	1.28	1.36	1.25	1.23	
STDEV (PCT.)	1.8	1.3	3.8	1.4	
K-40 (PCI/G)	20.2	21.8	22.8	25.7	
STDEV (PCT.)	.8	.6	1.5	.5	
CS-137 (PCI/G)	.262	.239	.151	.029	
STDEV (PCT.)	2.7	2.2	8.0	14.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01464	.00330
STDEV (PCT.)	3.5	10.3

BE25 INDEPENDENCE, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1506	3092	3704	21942	(694 SQ. CM.)
U-238 (PCI/G)	1.06	.82	.86	.74	
STDEV (PCT.)	1.5	1.3	1.8	1.4	
TH-232 (PCI/G)	1.29	.96	.99	.96	
STDEV (PCT.)	1.8	1.6	2.3	1.6	
K-40 (PCI/G)	23.2	32.7	32.6	34.2	
STDEV (PCT.)	.8	.4	.6	.5	
CS-137 (PCI/G)	.307	.176	.140	.035	
STDEV (PCT.)	2.4	2.7	4.6	11.9	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE29 CHINA LAKE, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2776	3523	4307	16905	(694 SQ. CM.)
U-238 (PCI/G)	.97	.80	.74	.80	
STDEV (PCT.)	1.2	1.3	1.4	.8	
TH-232 (PCI/G)	1.01	.86	.74	1.09	
STDEV (PCT.)	1.6	1.7	1.9	.9	
K-40 (PCI/G)	22.4	23.3	25.7	24.2	
STDEV (PCT.)	.6	.5	.5	.3	
CS-137 (PCI/G)	.152	.102	.052	.012	
STDEV (PCT.)	3.1	4.2	7.8	19.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE32 BEATTY, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1760	1765	4168	15286
U-238 (PCI/G)	1.24	1.26	1.26	1.18
STDEV (PCT.)	3.0	3.0	1.4	1.5
TH-232 (PCI/G)	1.51	1.67	1.69	1.67
STDEV (PCT.)	3.6	3.3	1.6	1.6
K-40 (PCI/G)	29.3	30.7	29.8	26.9
STDEV (PCT.)	1.4	1.4	.7	.7
CS-137 (PCI/G)	.605	.327	.100	.012
STDEV (PCT.)	3.2	4.8	6.6	47.1

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.20513	.00429
STDEV (PCT.)	3.0	7.7

BE34 CARVER'S, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1848	1333	2747	14032
U-238 (PCI/G)	1.80	2.02	1.99	2.08
STDEV (PCT.)	1.7	2.3	2.5	2.4
TH-232 (PCI/G)	1.80	1.91	1.79	1.81
STDEV (PCT.)	2.3	3.1	3.4	3.3
K-40 (PCI/G)	26.1	24.3	22.7	26.7
STDEV (PCT.)	1.1	1.6	1.8	1.6
CS-137 (PCI/G)	.179	.293	.647	.098
STDEV (PCT.)	5.7	5.7	3.4	14.2

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE37 ALAMO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2248	3573	3384	13498	(694 SQ. CM.)
U-238 (PCI/G)	1.35	1.40	1.52	1.40	
STDEV (PCT.)	2.8	2.8	1.2	1.2	
TH-232 (PCI/G)	1.33	1.39	1.46	1.66	
STDEV (PCT.)	3.8	3.7	1.7	1.6	
K-40 (PCI/G)	19.5	21.2	22.8	26.0	
STDEV (PCT.)	1.8	1.7	.8	.7	
CS-137 (PCI/G)	.440	.390	.265	.068	
STDEV (PCT.)	3.7	4.2	2.9	8.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.06839	.01526
STDEV (PCT.)	2.1	4.6

BE38 ALAMO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1712	3561	3793	15386	(694 SQ. CM.)
U-238 (PCI/G)	1.34	1.42	1.56	1.69	
STDEV (PCT.)	1.3	2.7	1.2	1.2	
TH-232 (PCI/G)	1.27	1.48	1.59	1.54	
STDEV (PCT.)	1.8	3.5	1.6	1.7	
K-40 (PCI/G)	18.3	22.4	23.9	20.0	
STDEV (PCT.)	.9	1.6	.8	.9	
CS-137 (PCI/G)	.413	.302	.123	.027	
STDEV (PCT.)	2.0	5.1	5.4	21.9	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE39 ALAMO, NEVADA

	1	2	3	4	
DRY WEIGHT (GMS)	2133	3471	2648	11080	(694 SQ. CM.)
U-238 (PCI/G)	2.08	2.04	1.87	1.83	
STDEV (PCT.)	2.2	2.2	2.3	2.3	
TH-232 (PCI/G)	1.43	1.52	1.53	1.51	
STDEV (PCT.)	3.7	3.5	3.5	3.5	
K-40 (PCI/G)	20.4	21.8	22.4	24.4	
STDEV (PCT.)	1.8	1.7	1.6	1.6	
CS-137 (PCI/G)	.383	.316	.236	.080	
STDEV (PCT.)	4.3	5.0	6.3	15.7	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BE40 ALAMO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1934	3819	3530	10989	(694 SQ. CM.)
U-238 (PCI/G)	1.08	1.27	1.36	1.35	
STDEV (PCT.)	3.2	2.9	2.8	2.8	
TH-232 (PCI/G)	1.40	1.49	1.53	1.58	
STDEV (PCT.)	3.6	3.5	3.5	3.4	
K-40 (PCI/G)	20.4	22.8	24.4	24.1	
STDEV (PCT.)	1.7	1.6	1.5	1.6	
CS-137 (PCI/G)	.276	.294	.255	.129	
STDEV (PCT.)	5.4	5.2	5.8	10.0	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BF01 BLUEBELL, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1104	1476	4926	18417
U-238 (PCI/G)	.63	.68	.74	.76
STDEV (PCT.)	3.1	4.0	3.7	3.6
TH-232 (PCI/G)	.57	.66	.75	.81
STDEV (PCT.)	4.5	5.7	5.0	4.8
K-40 (PCI/G)	9.6	10.6	11.2	10.4
STDEV (PCT.)	1.8	2.3	2.2	2.3
CS-137 (PCI/G)	.569	.548	.469	.171
STDEV (PCT.)	2.2	3.0	3.3	6.7

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BF03 ARCADIA, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2982	4497	4062	13741
U-238 (PCI/G)	1.07	1.06	1.12	1.09
STDEV (PCT.)	2.3	3.5	3.1	3.0
TH-232 (PCI/G)	1.12	1.21	1.16	1.12
STDEV (PCT.)	2.9	4.0	4.0	4.0
K-40 (PCI/G)	15.3	16.1	15.8	15.1
STDEV (PCT.)	1.4	2.1	2.0	2.0
CS-137 (PCI/G)	.447	.474	.244	.079
STDEV (PCT.)	2.6	3.7	5.7	13.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02700	.00742
STDEV (PCT.)	5.2	8.1

BF05 ALTONAH, UTAH

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2187	3654	3576	9990
U-238 (PCI/G)	.83	.81	.87	.82
STDEV (PCT.)	3.6	3.7	3.4	3.7
TH-232 (PCI/G)	.74	.79	.82	.74
STDEV (PCT.)	5.3	5.0	4.8	5.3
K-40 (PCI/G)	11.6	11.4	11.7	9.8
STDEV (PCT.)	2.2	2.3	2.2	2.6
CS-137 (PCI/G)	.502	.372	.212	.075
STDEV (PCT.)	3.2	4.0	5.9	13.7

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03060	.00751
STDEV (PCT.)	4.0	5.6

BF09 ALTONAH, UTAH

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1108	870	4128	18556
U-238 (PCI/G)	.58	.65	.61	.70
STDEV (PCT.)	4.4	4.1	4.1	3.8
TH-232 (PCI/G)	.48	.55	.51	.66
STDEV (PCT.)	6.9	6.2	6.5	5.3
K-40 (PCI/G)	7.3	7.7	7.4	8.6
STDEV (PCT.)	2.8	2.7	2.8	2.5
CS-137 (PCI/G)	.403	.453	.487	.076
STDEV (PCT.)	3.6	3.3	3.1	12.4

**** NO PLUTONIUM ANALYSIS PERFORMED ****

BF10 DUCHESNE, UTAH

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2927	4488	4355	12974
U-238 (PCI/G)	.99	1.02	1.01	1.02
STDEV (PCT.)	3.3	3.2	3.3	1.6
TH-232 (PCI/G)	1.05	1.01	1.07	1.08
STDEV (PCT.)	4.3	4.4	4.3	2.0
K-40 (PCI/G)	16.7	15.7	16.6	15.9
STDEV (PCT.)	1.9	2.0	1.9	1.0
CS-137 (PCI/G)	.497	.178	.100	.032
STDEV (PCT.)	3.3	7.1	11.7	17.7

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01950	.00392
STDEV (PCT.)	5.8	10.0

BF13 RIVERTON, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3124	3887	3595	13066
U-238 (PCI/G)	1.15	1.11	1.14	1.13
STDEV (PCT.)	3.0	3.1	3.0	3.0
TH-232 (PCI/G)	1.49	1.35	1.38	1.41
STDEV (PCT.)	3.4	3.7	3.6	3.6
K-40 (PCI/G)	18.2	17.8	18.2	19.2
STDEV (PCT.)	1.8	1.8	1.8	1.7
CS-137 (PCI/G)	.456	.345	.273	.054
STDEV (PCT.)	3.6	4.5	5.2	20.8

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04192	.01266
STDEV (PCT.)	2.8	3.8

BF15 RAWLINS, WYOMING

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2435	3135	2781	10486
U-238 (PCI/G)	1.01	1.06	1.07	.98
STDEV (PCT.)	3.1	3.0	3.0	3.1
TH-232 (PCI/G)	.84	.87	.88	.90
STDEV (PCT.)	5.0	4.7	4.6	4.6
K-40 (PCI/G)	15.0	14.2	15.2	15.7
STDEV (PCT.)	1.9	2.0	1.9	1.8
CS-137 (PCI/G)	.485	.444	.393	.122
STDEV (PCT.)	3.4	3.5	3.8	9.1

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02546	.00827
STDEV (PCT.)	3.6	5.2

BF19 UPALCO, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1831	4240	3372	3455
U-238 (PCI/G)	.45	.48	.49	.61
STDEV (PCT.)	5.2	4.6	4.4	3.9
TH-232 (PCI/G)	.34	.43	.52	.61
STDEV (PCT.)	9.0	7.0	5.8	5.4
K-40 (PCI/G)	5.1	5.6	5.7	7.6
STDEV (PCT.)	3.4	3.1	3.0	2.6
CS-137 (PCI/G)	.769	.558	.144	.097
STDEV (PCT.)	2.3	2.7	6.8	9.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03870	.00938
STDEV (PCT.)	3.7	5.3

BF22 BLUEBELL, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2050	3111	4397	15582
U-238 (PCI/G)	.48	.44	.51	.50
STDEV (PCT.)	5.1	5.0	4.3	3.0
TH-232 (PCI/G)	.46	.43	.47	.42
STDEV (PCT.)	7.0	7.0	6.4	4.9
K-40 (PCI/G)	5.4	5.0	5.4	5.1
STDEV (PCT.)	3.4	3.4	3.1	2.3
CS-137 (PCI/G)	.677	.466	.148	.004
STDEV (PCT.)	2.6	3.1	6.6	138.4

**** NO PLUTONIUM ANALYSIS PERFORMED ****

DZ01 BAKER, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2579	2956	3960	14881	(694 SQ. CM.)
U-238 (PCI/G)	.90	.88	.78	.78	
STDEV (PCT.)	1.6	2.4	3.7	3.6	
TH-232 (PCI/G)	.89	.98	.89	.91	
STDEV (PCT.)	2.3	3.0	4.7	4.4	
K-40 (PCI/G)	15.5	16.8	15.3	15.9	
STDEV (PCT.)	.9	1.3	1.9	1.8	
CS-137 (PCI/G)	.680	.445	.228	.067	
STDEV (PCT.)	1.3	2.5	5.5	14.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04139	.01462
STDEV (PCT.)	4.1	4.4

DZ04 ELY, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1903	2537	2776	12213	(694 SQ. CM.)
U-238 (PCI/G)	2.58	3.21	3.16	1.66	
STDEV (PCT.)	1.9	.8	1.2	1.4	
TH-232 (PCI/G)	1.07	1.12	1.16	1.02	
STDEV (PCT.)	4.5	2.2	3.1	2.6	
K-40 (PCI/G)	12.1	13.6	14.5	13.6	
STDEV (PCT.)	2.3	1.1	1.6	1.2	
CS-137 (PCI/G)	1.359	.689	.272	.038	
STDEV (PCT.)	1.8	1.5	4.0	16.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.11117	.02385
STDEV (PCT.)	3.3	3.7

DZ04A ELY, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1313	1531	3687	19294	(694 SQ. CM.)
U-238 (PCI/G)	.96	.96	.84	1.32	
STDEV (PCT.)	3.4	3.4	3.7	.9	
TH-232 (PCI/G)	.88	.70	.62	1.29	
STDEV (PCT.)	4.8	5.7	6.0	1.2	
K-40 (PCI/G)	11.6	10.3	9.6	19.3	
STDEV (PCT.)	2.3	2.5	2.6	.5	
CS-137 (PCI/G)	1.602	.679	.058	.008	
STDEV (PCT.)	1.6	2.7	17.0	41.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

DZ05A ELY, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2192	3215	3322	8080	(694 SQ. CM.)
U-238 (PCI/G)	1.42	1.50	1.50	1.19	
STDEV (PCT.)	1.3	1.8	1.5	2.9	
TH-232 (PCI/G)	1.02	1.02	1.09	.90	
STDEV (PCT.)	2.3	3.2	2.5	4.8	
K-40 (PCI/G)	15.7	15.2	16.7	14.4	
STDEV (PCT.)	1.0	1.4	1.1	2.1	
CS-137 (PCI/G)	.561	.542	.438	.140	
STDEV (PCT.)	1.6	2.3	2.2	8.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.10050	.01428
STDEV (PCT.)	3.7	5.5

DZ09 MCGILL, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1778	2739	3352	12468	(694 SQ. CM.)
U-238 (PCI/G)	1.64	1.30	1.35	1.23	
STDEV (PCT.)	2.6	3.0	2.9	3.0	
TH-232 (PCI/G)	.82	1.03	1.10	1.06	
STDEV (PCT.)	5.6	4.5	4.4	4.4	
K-40 (PCI/G)	20.8	19.9	17.1	15.4	
STDEV (PCT.)	1.8	1.8	2.0	2.1	
CS-137 (PCI/G)	2.222	.180	.034	.021	
STDEV (PCT.)	1.4	7.6	32.2	50.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.08055	.00101
STDEV (PCT.)	3.4	13.8

DZ10 IBAPAH, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	957	1532	3593	13640	(694 SQ. CM.)
U-238 (PCI/G)	.94	.94	.96	.93	
STDEV (PCT.)	4.1	2.7	3.7	3.7	
TH-232 (PCI/G)	.91	.85	.93	.70	
STDEV (PCT.)	5.3	3.7	4.7	5.9	
K-40 (PCI/G)	13.6	13.4	12.4	11.3	
STDEV (PCT.)	2.3	1.6	2.4	2.5	
CS-137 (PCI/G)	3.084	1.108	.124	.021	
STDEV (PCT.)	1.2	1.5	9.9	47.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.10998	.00272
STDEV (PCT.)	3.2	8.9

DZ16 WENDOVER, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2340	4181	3505	15198	(694 SQ. CM.)
U-238 (PCI/G)	1.14	1.01	1.04	.96	
STDEV (PCT.)	2.2	2.4	1.6	2.3	
TH-232 (PCI/G)	1.06	1.51	1.42	.68	
STDEV (PCT.)	3.1	2.4	1.8	3.9	
K-40 (PCI/G)	14.8	19.8	17.3	8.1	
STDEV (PCT.)	1.5	1.2	.9	1.9	
CS-137 (PCI/G)	.751	.271	.249	.064	
STDEV (PCT.)	1.8	3.8	2.9	10.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03929	.00616
STDEV (PCT.)	4.2	5.7

DZ18 TOOELE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2360	3842	3860	13701	(694 SQ. CM.)
U-238 (PCI/G)	1.21	1.30	1.32	1.22	
STDEV (PCT.)	3.0	2.7	2.8	2.9	
TH-232 (PCI/G)	.80	.84	.89	.81	
STDEV (PCT.)	5.3	4.9	4.8	5.2	
K-40 (PCI/G)	13.0	13.9	13.8	13.7	
STDEV (PCT.)	2.2	2.1	2.1	2.1	
CS-137 (PCI/G)	.714	.648	.448	.105	
STDEV (PCT.)	2.6	2.7	3.6	10.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03847	.01135
STDEV (PCT.)	3.6	4.4

DZ21 IOSEPA, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2420	3785	3185	13749	(694 SQ. CM.)
U-238 (PCI/G)	1.19	1.20	1.13	1.16	
STDEV (PCT.)	3.0	2.9	3.1	2.1	
TH-232 (PCI/G)	1.00	1.11	1.00	1.02	
STDEV (PCT.)	4.5	4.1	4.6	3.0	
K-40 (PCI/G)	15.7	15.4	14.6	15.1	
STDEV (PCT.)	2.0	2.0	2.1	1.4	
CS-137 (PCI/G)	.676	.565	.379	.114	
STDEV (PCT.)	2.8	3.1	4.0	7.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05771	.01779
STDEV (PCT.)	3.2	3.7

EML3 ST. GEORGE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1572	3305	3895	10851
U-238 (PCI/G)	.48	.51	.53	.48
STDEV (PCT.)	5.3	5.1	5.0	3.6
TH-232 (PCI/G)	.43	.47	.56	.39
STDEV (PCT.)	7.9	7.9	6.4	5.7
K-40 (PCI/G)	14.4	15.8	14.5	11.8
STDEV (PCT.)	2.1	2.0	2.0	1.6
CS-137 (PCI/G)	.574	.622	.360	.058
STDEV (PCT.)	3.0	2.8	4.0	11.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05305	.01081
STDEV (PCT.)	3.3	4.7

E20A KANAB, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2249	3554	3370	13069
U-238 (PCI/G)	.79	.81	.84	.84
STDEV (PCT.)	2.6	2.6	2.5	2.5
TH-232 (PCI/G)	.66	.72	.77	.78
STDEV (PCT.)	4.1	3.9	3.7	3.7
K-40 (PCI/G)	16.6	17.5	17.5	19.0
STDEV (PCT.)	1.3	1.3	1.3	1.2
CS-137 (PCI/G)	.433	.459	.299	.066
STDEV (PCT.)	2.5	2.4	3.3	11.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02735	.00783
STDEV (PCT.)	3.6	5.2

E26A PAROWAN, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2833	3910	3885	11380
U-238 (PCI/G)	.64	.69	.65	.55
STDEV (PCT.)	4.1	3.9	4.1	4.4
TH-232 (PCI/G)	.56	.54	.65	.56
STDEV (PCT.)	6.2	6.3	5.5	5.9
K-40 (PCI/G)	6.4	6.5	6.0	6.0
STDEV (PCT.)	3.0	3.0	3.2	3.1
CS-137 (PCI/G)	.483	.595	.382	.101
STDEV (PCT.)	3.2	2.7	3.8	9.3

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02708	.00970
STDEV (PCT.)	2.7	4.7

E35 CEDAR CITY, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2353	4090	3784	11899
U-238 (PCI/G)	.54	.58	.57	.61
STDEV (PCT.)	3.3	2.2	3.1	2.5
TH-232 (PCI/G)	.49	.54	.55	.58
STDEV (PCT.)	4.9	3.2	4.4	3.5
K-40 (PCI/G)	11.0	11.5	11.5	12.9
STDEV (PCT.)	1.6	1.1	1.6	1.2
CS-137 (PCI/G)	.387	.355	.248	.077
STDEV (PCT.)	2.6	2.0	3.5	7.7

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01936	.00775
STDEV (PCT.)	3.8	5.9

E132 VERNAL, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2850	4348	3881	15105
U-238 (PCI/G)	.97	1.06	.99	.85
STDEV (PCT.)	3.3	3.1	3.3	3.2
TH-232 (PCI/G)	.80	.72	.74	.73
STDEV (PCT.)	5.0	5.7	5.4	5.1
K-40 (PCI/G)	13.7	13.4	13.5	11.8
STDEV (PCT.)	2.1	2.1	2.1	2.1
CS-137 (PCI/G)	.477	.294	.186	.057
STDEV (PCT.)	3.3	4.7	6.7	18.3

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02199	.00628
STDEV (PCT.)	3.7	5.9

FM01 KINGMAN, ARIZONA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1396	4679	4852	16542	(694 SQ. CM.)
U-238 (PCI/G)	.81	.84	1.02	.95	
STDEV (PCT.)	4.2	1.8	3.4	1.7	
TH-232 (PCI/G)	1.39	1.50	1.60	1.65	
STDEV (PCT.)	3.8	1.7	3.3	1.6	
K-40 (PCI/G)	20.2	28.3	25.8	28.4	
STDEV (PCT.)	1.8	.7	1.5	.7	
CS-137 (PCI/G)	1.159	.122	.072	.048	
STDEV (PCT.)	2.1	5.3	17.1	12.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01339	.00424
STDEV (PCT.)	3.5	5.4

FM08 SOUTH RIM GRAND CANYON, ARIZONA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	606	1241	3763	15974	(694 SQ. CM.)
U-238 (PCI/G)	.93	1.08	1.02	1.05	
STDEV (PCT.)	4.1	3.3	3.1	3.2	
TH-232 (PCI/G)	.76	.97	.98	1.30	
STDEV (PCT.)	5.5	4.8	4.4	3.7	
K-40 (PCI/G)	11.7	16.3	16.1	18.6	
STDEV (PCT.)	2.6	2.0	1.9	1.8	
CS-137 (PCI/G)	1.439	1.244	.521	.090	
STDEV (PCT.)	1.9	2.0	3.2	13.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.07202	.01270
STDEV (PCT.)	3.2	4.7

FM10 SOUTH RIM GRAND CANYON, ARIZONA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1505	1662	4390	15460	(694 SQ. CM.)
U-238 (PCI/G)	.76	.78	.78	.78	
STDEV (PCT.)	3.6	3.5	3.5	3.5	
TH-232 (PCI/G)	.68	.76	.67	.72	
STDEV (PCT.)	5.5	4.9	5.4	5.0	
K-40 (PCI/G)	9.7	10.2	9.4	9.2	
STDEV (PCT.)	2.3	2.3	2.4	2.4	
CS-137 (PCI/G)	.888	.712	.303	.048	
STDEV (PCT.)	2.2	2.4	4.2	18.3	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

FM14 TUBA CITY, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2825	4558	3854	13164	(694 SQ. CM.)
U-238 (PCI/G)	.61	.67	.69	.64	
STDEV (PCT.)	4.4	3.9	4.0	4.1	
TH-232 (PCI/G)	.51	.63	.60	.58	
STDEV (PCT.)	7.0	5.7	6.1	6.2	
K-40 (PCI/G)	15.5	14.8	15.1	15.2	
STDEV (PCT.)	1.9	2.0	1.9	1.9	
CS-137 (PCI/G)	.213	.293	.253	.041	
STDEV (PCT.)	5.6	4.6	4.9	23.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01138	.01224
STDEV (PCT.)	4.8	4.9

FM16 GALLUP, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2573	3839	3960	19317	(694 SQ. CM.)
U-238 (PCI/G)	1.07	1.00	.96	1.22	
STDEV (PCT.)	3.2	3.2	3.2	2.8	
TH-232 (PCI/G)	.94	1.16	1.13	1.30	
STDEV (PCT.)	4.8	3.9	3.9	3.7	
K-40 (PCI/G)	16.2	20.7	20.3	15.8	
STDEV (PCT.)	1.9	1.6	1.6	1.9	
CS-137 (PCI/G)	1.095	.241	.077	.032	
STDEV (PCT.)	2.1	5.6	14.0	32.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03477	.00178
STDEV (PCT.)	3.8	11.5

FM17 HOLBROOK, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2460	3262	3184	16699	(694 SQ. CM.)
U-238 (PCI/G)	.78	.69	.64	.67	
STDEV (PCT.)	3.7	3.9	4.1	3.8	
TH-232 (PCI/G)	.78	.67	.65	.70	
STDEV (PCT.)	4.9	5.5	5.6	5.2	
K-40 (PCI/G)	12.4	12.5	12.8	12.8	
STDEV (PCT.)	2.2	2.1	2.1	2.0	
CS-137 (PCI/G)	.364	.372	.242	.059	
STDEV (PCT.)	3.9	3.8	5.1	15.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01787	.00790
STDEV (PCT.)	4.1	6.2

FM29 GANADO, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3071	4482	4780	20410	(694 SQ. CM.)
U-238 (PCI/G)	.73	.78	.83	.65	
STDEV (PCT.)	3.9	3.7	3.5	1.9	
TH-232 (PCI/G)	.67	.87	.85	.79	
STDEV (PCT.)	5.9	4.6	4.8	2.4	
K-40 (PCI/G)	16.4	16.6	16.9	18.4	
STDEV (PCT.)	1.9	1.8	1.8	.8	
CS-137 (PCI/G)	.608	.227	.110	.021	
STDEV (PCT.)	2.9	5.5	9.6	23.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04609	.00275
STDEV (PCT.)	3.3	7.7

FM31 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2308	3728	3953	15625	(694 SQ. CM.)
U-238 (PCI/G)	.99	1.04	1.00	.86	
STDEV (PCT.)	3.5	3.1	3.3	1.7	
TH-232 (PCI/G)	.81	.94	.98	.84	
STDEV (PCT.)	5.2	4.5	4.5	2.4	
K-40 (PCI/G)	13.6	15.7	15.9	17.5	
STDEV (PCT.)	2.2	1.9	1.9	.9	
CS-137 (PCI/G)	.806	.224	.112	.036	
STDEV (PCT.)	2.5	5.8	10.8	14.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.06173	.00639
STDEV (PCT.)	3.5	5.3

FM32 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2298	4003	4847	16232	(694 SQ. CM.)
U-238 (PCI/G)	.79	.85	.84	.98	
STDEV (PCT.)	3.9	3.5	3.5	3.3	
TH-232 (PCI/G)	.69	.80	.77	.88	
STDEV (PCT.)	5.8	5.1	5.1	4.9	
K-40 (PCI/G)	14.7	15.9	16.7	16.4	
STDEV (PCT.)	2.1	1.9	1.8	1.9	
CS-137 (PCI/G)	.557	.323	.151	.040	
STDEV (PCT.)	3.2	4.6	8.1	27.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.09323	.00756
STDEV (PCT.)	3.6	5.8

FM33 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1481	3406	4647	21009	(694 SQ. CM.)
U-238 (PCI/G)	.71	.92	.82	.90	
STDEV (PCT.)	4.5	2.4	3.5	3.3	
TH-232 (PCI/G)	.60	.84	.87	.97	
STDEV (PCT.)	6.4	3.4	4.7	4.4	
K-40 (PCI/G)	9.3	14.8	17.3	18.0	
STDEV (PCT.)	2.8	1.4	1.8	1.7	
CS-137 (PCI/G)	.698	.727	.178	.053	
STDEV (PCT.)	2.8	1.8	6.7	17.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.09593	.00474
STDEV (PCT.)	2.9	7.0

FM33-R ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1481	3406	4647	21009	(694 SQ. CM.)
U-238 (PCI/G)	.79	.89	.81	.85	
STDEV (PCT.)	4.1	3.5	3.6	3.4	
TH-232 (PCI/G)	.56	.80	.93	.95	
STDEV (PCT.)	6.9	5.2	4.4	4.4	
K-40 (PCI/G)	8.9	14.7	16.6	17.7	
STDEV (PCT.)	2.9	2.0	1.8	1.7	
CS-137 (PCI/G)	.653	.697	.205	.040	
STDEV (PCT.)	3.1	2.7	6.3	25.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.10254	.00700
STDEV (PCT.)	2.9	4.7

FM34 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1403	2977	3780	16698	(694 SQ. CM.)
U-238 (PCI/G)	.77	.98	1.07	1.10	
STDEV (PCT.)	4.2	3.4	3.3	3.2	
TH-232 (PCI/G)	.63	.80	.98	1.06	
STDEV (PCT.)	6.2	5.3	4.6	4.3	
K-40 (PCI/G)	9.6	14.1	16.6	17.8	
STDEV (PCT.)	2.8	2.1	2.0	1.8	
CS-137 (PCI/G)	.543	.812	.167	.051	
STDEV (PCT.)	3.4	2.6	8.2	22.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.16154	.00877
STDEV (PCT.)	3.8	5.8

FM35 ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1598	3579	3984	20880	(694 SQ. CM.)
U-238 (PCI/G)	.86	.84	.89	.78	
STDEV (PCT.)	4.0	3.5	3.4	3.6	
TH-232 (PCI/G)	.64	.96	.99	.87	
STDEV (PCT.)	6.2	4.4	4.3	4.6	
K-40 (PCI/G)	10.9	14.1	15.3	18.0	
STDEV (PCT.)	2.6	2.0	1.9	1.7	
CS-137 (PCI/G)	.837	.475	.187	.031	
STDEV (PCT.)	2.5	3.3	6.6	30.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.21524	.01210
STDEV (PCT.)	1.7	4.2

FM35-R ALBUQUERQUE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1598	3579	3984	20880	(694 SQ. CM.)
U-238 (PCI/G)	.81	.94	.86	.71	
STDEV (PCT.)	4.2	3.3	3.5	4.0	
TH-232 (PCI/G)	.62	.85	.94	.83	
STDEV (PCT.)	6.5	4.8	4.5	4.9	
K-40 (PCI/G)	10.4	13.9	14.5	17.6	
STDEV (PCT.)	2.6	2.0	2.0	1.7	
CS-137 (PCI/G)	.818	.481	.162	.040	
STDEV (PCT.)	2.7	3.4	7.7	24.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.22372	.01090
STDEV (PCT.)	3.4	5.2

FM39 CHINLE, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3071	3843	4262	16977	(694 SQ. CM.)
U-238 (PCI/G)	1.02	.95	.95	.81	
STDEV (PCT.)	3.1	3.2	3.3	3.6	
TH-232 (PCI/G)	.96	1.01	.93	1.05	
STDEV (PCT.)	4.5	4.2	4.5	4.1	
K-40 (PCI/G)	14.0	14.9	14.3	14.7	
STDEV (PCT.)	2.0	1.9	2.0	1.9	
CS-137 (PCI/G)	.500	.404	.163	.057	
STDEV (PCT.)	3.3	3.7	7.3	17.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03840	.00452
STDEV (PCT.)	4.0	4.9

FM43 WILLIAMS, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2337	3305	3304	10994	(694 SQ. CM.)
U-238 (PCI/G)	.81	.94	1.01	1.08	
STDEV (PCT.)	3.8	3.4	1.9	3.2	
TH-232 (PCI/G)	.80	1.01	1.07	1.38	
STDEV (PCT.)	5.1	4.3	2.4	3.5	
K-40 (PCI/G)	13.2	14.4	12.8	11.0	
STDEV (PCT.)	2.2	2.0	1.3	2.4	
CS-137 (PCI/G)	1.372	.539	.285	.069	
STDEV (PCT.)	1.8	3.2	2.9	15.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03881	.00638
STDEV (PCT.)	3.2	5.8

FM45 FLAGSTAFF, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2288	3490	3744	15565	(694 SQ. CM.)
U-238 (PCI/G)	.89	.92	.91	.95	
STDEV (PCT.)	3.7	2.5	3.5	3.4	
TH-232 (PCI/G)	.93	1.01	1.04	1.13	
STDEV (PCT.)	4.7	3.1	4.2	4.0	
K-40 (PCI/G)	13.7	14.3	14.6	14.8	
STDEV (PCT.)	2.2	1.5	2.0	2.0	
CS-137 (PCI/G)	.569	.478	.290	.076	
STDEV (PCT.)	3.1	2.4	4.7	14.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02428	.00628
STDEV (PCT.)	3.6	5.1

FM46 FLAGSTAFF, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2002	3451	3847	12980	(694 SQ. CM.)
U-238 (PCI/G)	.78	1.00	1.09	.96	
STDEV (PCT.)	4.2	3.3	3.3	3.3	
TH-232 (PCI/G)	.82	1.10	1.20	1.16	
STDEV (PCT.)	5.3	4.1	4.0	4.0	
K-40 (PCI/G)	11.5	12.6	12.5	10.8	
STDEV (PCT.)	2.4	2.2	2.3	2.3	
CS-137 (PCI/G)	2.157	.124	.049	.007	
STDEV (PCT.)	1.5	9.5	22.1	132.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04665	.00196
STDEV (PCT.)	2.8	11.3

FM50 FLAGSTAFF, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2878	4084	3953	16238	(694 SQ. CM.)
U-238 (PCI/G)	.93	1.08	.95	1.07	
STDEV (PCT.)	3.5	3.3	3.4	3.3	
TH-232 (PCI/G)	.99	1.12	1.00	1.23	
STDEV (PCT.)	4.4	4.1	4.4	3.9	
K-40 (PCI/G)	14.5	14.8	14.7	14.7	
STDEV (PCT.)	2.0	2.1	2.0	2.1	
CS-137 (PCI/G)	1.049	.085	.277	.004	
STDEV (PCT.)	2.1	13.6	5.0	303.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

FM54 FT. DEFIANCE, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3464	4751	4668	18586	(694 SQ. CM.)
U-238 (PCI/G)	.66	.72	.69	.61	
STDEV (PCT.)	2.0	1.9	2.0	2.1	
TH-232 (PCI/G)	.72	.79	.76	.66	
STDEV (PCT.)	2.6	2.4	2.5	2.8	
K-40 (PCI/G)	21.4	22.5	23.4	23.6	
STDEV (PCT.)	.8	.8	.8	.7	
CS-137 (PCI/G)	.290	.175	.096	.026	
STDEV (PCT.)	2.4	3.6	5.9	19.0	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

GC05 RENO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2698	3762	4805	19151	(694 SQ. CM.)
U-238 (PCI/G)	.94	.91	.86	1.02	
STDEV (PCT.)	1.2	1.6	3.5	1.5	
TH-232 (PCI/G)	1.24	1.22	1.16	1.38	
STDEV (PCT.)	1.4	1.8	4.0	1.7	
K-40 (PCI/G)	16.1	17.8	24.1	21.6	
STDEV (PCT.)	.7	.9	1.5	.8	
CS-137 (PCI/G)	.309	.257	.114	.033	
STDEV (PCT.)	1.7	2.6	10.7	16.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01369	.00292
STDEV (PCT.)	5.8	8.4

GC12 LOVELOCK, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1619	2506	3118	16182	(694 SQ. CM.)
U-238 (PCI/G)	1.21	1.32	1.38	1.17	
STDEV (PCT.)	1.7	3.1	3.0	1.5	
TH-232 (PCI/G)	1.07	1.21	1.28	1.10	
STDEV (PCT.)	2.2	4.2	4.0	2.0	
K-40 (PCI/G)	16.5	19.2	20.1	21.3	
STDEV (PCT.)	1.1	1.9	1.9	.8	
CS-137 (PCI/G)	.914	.325	.186	.019	
STDEV (PCT.)	1.2	5.0	7.6	29.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02620	.00263
STDEV (PCT.)	3.8	8.4

GC15 FALLON, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2374	4452	4344	15644	(694 SQ. CM.)
U-238 (PCI/G)	.73	.79	.77	.85	
STDEV (PCT.)	4.0	3.6	3.6	3.5	
TH-232 (PCI/G)	.86	.92	.84	.91	
STDEV (PCT.)	4.8	4.5	4.8	4.6	
K-40 (PCI/G)	20.6	23.0	22.9	22.6	
STDEV (PCT.)	1.7	1.5	1.5	1.5	
CS-137 (PCI/G)	.341	.267	.252	.061	
STDEV (PCT.)	4.3	4.9	5.1	17.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01417	.00574
STDEV (PCT.)	4.6	6.0

GC19 GABBS, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1700	3076	3501	12514	(694 SQ. CM.)
U-238 (PCI/G)	.95	1.06	.93	.84	
STDEV (PCT.)	3.3	3.1	3.3	2.4	
TH-232 (PCI/G)	.75	.75	.73	.79	
STDEV (PCT.)	5.4	5.3	5.4	3.5	
K-40 (PCI/G)	14.7	16.0	16.9	17.4	
STDEV (PCT.)	2.0	1.9	1.8	1.2	
CS-137 (PCI/G)	.367	.670	.357	.026	
STDEV (PCT.)	4.0	2.7	4.0	25.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04020	.00325
STDEV (PCT.)	2.4	7.0

GC20 AUSTIN, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1689	3063	3467	14573	(694 SQ. CM.)
U-238 (PCI/G)	1.52	1.50	1.65	1.67	
STDEV (PCT.)	2.7	2.6	2.4	1.3	
TH-232 (PCI/G)	1.94	1.85	2.00	2.40	
STDEV (PCT.)	3.0	3.0	2.9	1.4	
K-40 (PCI/G)	23.4	27.6	28.1	25.6	
STDEV (PCT.)	1.6	1.4	1.4	.8	
CS-137 (PCI/G)	.808	.724	.164	.057	
STDEV (PCT.)	2.6	2.7	8.2	12.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04035	.00413
STDEV (PCT.)	5.6	7.3

GC23 AUSTIN, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1064	1263	4101	17959	(694 SQ. CM.)
U-238 (PCI/G)	1.34	1.37	1.42	1.45	
STDEV (PCT.)	2.9	2.9	2.9	2.7	
TH-232 (PCI/G)	1.16	1.25	1.26	1.22	
STDEV (PCT.)	4.2	4.1	4.1	4.1	
K-40 (PCI/G)	20.0	22.0	22.4	25.6	
STDEV (PCT.)	1.8	1.7	1.7	1.6	
CS-137 (PCI/G)	.941	.953	.716	.102	
STDEV (PCT.)	2.3	2.3	2.8	12.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05001	.01271
STDEV (PCT.)	3.4	4.8

GC29 BRIDGEPORT, CALIFORNIA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1996	2952	3785	16746	(694 SQ. CM.)
U-238 (PCI/G)	1.21	1.14	1.41	.97	
STDEV (PCT.)	3.0	3.1	2.7	3.4	
TH-232 (PCI/G)	1.28	1.37	1.46	.92	
STDEV (PCT.)	3.8	3.7	3.6	4.8	
K-40 (PCI/G)	19.6	18.6	24.1	30.5	
STDEV (PCT.)	1.7	1.8	1.6	1.4	
CS-137 (PCI/G)	.725	.940	.157	.012	
STDEV (PCT.)	2.7	2.3	8.5	84.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02692	.00286
STDEV (PCT.)	3.7	9.5

GC33 HAWTHORNE, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3207	4694	4852	17969	(694 SQ. CM.)
U-238 (PCI/G)	1.54	1.13	1.17	1.21	
STDEV (PCT.)	2.4	1.4	2.8	1.3	
TH-232 (PCI/G)	1.55	1.22	1.34	1.37	
STDEV (PCT.)	3.3	1.8	3.6	1.7	
K-40 (PCI/G)	22.6	25.1	25.5	27.2	
STDEV (PCT.)	1.6	.7	1.4	.7	
CS-137 (PCI/G)	.686	.111	.045	.017	
STDEV (PCT.)	2.7	5.2	24.8	31.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01766	.00138
STDEV (PCT.)	4.5	13.4

GC39 YERINGTON, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2845	4848	4630	18435	(694 SQ. CM.)
U-238 (PCI/G)	1.04	.98	1.05	1.04	
STDEV (PCT.)	1.5	1.6	2.9	1.5	
TH-232 (PCI/G)	1.14	1.17	1.22	1.25	
STDEV (PCT.)	2.0	1.9	3.8	1.8	
K-40 (PCI/G)	22.6	24.9	25.0	24.9	
STDEV (PCT.)	.7	.7	1.4	.7	
CS-137 (PCI/G)	.467	.163	.054	.018	
STDEV (PCT.)	1.7	3.7	19.5	28.6	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

GC43 GARDNERVILLE, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2038	3133	3582	15170	(694 SQ. CM.)
U-238 (PCI/G)	1.15	1.25	1.24	1.12	
STDEV (PCT.)	1.5	2.9	2.8	1.5	
TH-232 (PCI/G)	1.44	1.52	1.54	1.47	
STDEV (PCT.)	1.7	3.4	3.3	1.7	
K-40 (PCI/G)	16.0	17.1	17.7	18.6	
STDEV (PCT.)	1.0	1.9	1.8	.8	
CS-137 (PCI/G)	.358	.326	.199	.048	
STDEV (PCT.)	2.1	4.6	6.5	11.9	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

GC48 STEWART, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1717	3218	3418	14536	(694 SQ. CM.)
U-238 (PCI/G)	1.35	1.15	1.18	1.06	
STDEV (PCT.)	2.8	3.0	2.1	3.0	
TH-232 (PCI/G)	1.23	1.08	1.14	1.03	
STDEV (PCT.)	4.0	4.3	2.9	4.3	
K-40 (PCI/G)	17.6	18.4	19.3	22.5	
STDEV (PCT.)	1.8	1.8	1.2	1.5	
CS-137 (PCI/G)	.583	.457	.272	.042	
STDEV (PCT.)	3.1	3.5	3.5	23.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02542	.00390
STDEV (PCT.)	4.3	7.0

GC50 MOORES STATION, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2016	4179	3539	12050	(694 SQ. CM.)
U-238 (PCI/G)	2.16	2.35	2.34	2.31	
STDEV (PCT.)	2.1	2.0	2.0	1.0	
TH-232 (PCI/G)	2.07	2.13	2.16	2.30	
STDEV (PCT.)	2.9	2.9	2.8	1.3	
K-40 (PCI/G)	28.7	29.8	29.0	30.0	
STDEV (PCT.)	1.4	1.4	1.4	.7	
CS-137 (PCI/G)	.697	.396	.065	.016	
STDEV (PCT.)	2.9	4.3	19.8	39.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03566	.00144
STDEV (PCT.)	2.8	10.6

KM01 MEMPHIS, TENNESEE

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2963	4218	4205	16360
U-238 (PCI/G)	1.21	1.20	1.24	1.24
STDEV (PCT.)	1.4	3.0	3.0	1.4
TH-232 (PCI/G)	1.08	1.25	1.23	1.27
STDEV (PCT.)	2.0	3.9	3.9	1.8
K-40 (PCI/G)	13.2	14.8	14.4	14.4
STDEV (PCT.)	1.1	2.1	2.1	1.0
CS-137 (PCI/G)	.301	.276	.220	.059
STDEV (PCT.)	2.5	5.2	6.3	10.0

**** NO PLUTONIUM ANALYSIS PERFORMED ****

KM06 MEMPHIS, TENNESSEE

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1926	3942	4150	14132
U-238 (PCI/G)	1.00	1.11	1.19	1.16
STDEV (PCT.)	3.4	3.1	3.0	3.0
TH-232 (PCI/G)	.79	.95	.93	.95
STDEV (PCT.)	5.4	4.5	4.8	4.6
K-40 (PCI/G)	12.2	13.6	15.0	14.0
STDEV (PCT.)	2.3	2.1	2.1	2.1
CS-137 (PCI/G)	1.107	.874	.330	.043
STDEV (PCT.)	2.1	2.3	4.4	25.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04117	.00411
STDEV (PCT.)	3.4	7.8

KM13 DALLAS, TEXAS

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3147	2750	3339	17557	(694 SQ. CM.)
U-238 (PCI/G)	.46	.48	.45	.48	
STDEV (PCT.)	4.7	4.7	4.6	4.5	
TH-232 (PCI/G)	.40	.45	.37	.51	
STDEV (PCT.)	7.5	6.7	7.7	6.0	
K-40 (PCI/G)	3.5	3.3	2.7	3.0	
STDEV (PCT.)	4.0	4.3	4.6	4.3	
CS-137 (PCI/G)	.747	.392	.106	.025	
STDEV (PCT.)	2.3	3.5	8.2	28.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02734	.00143
STDEV (PCT.)	3.5	10.9

KM18 CORPUS CHRISTI, TEXAS

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1204	3378	2683	14122	(694 SQ. CM.)
U-238 (PCI/G)	.68	.76	.82	.83	
STDEV (PCT.)	4.2	3.9	1.8	1.8	
TH-232 (PCI/G)	.67	.88	.87	.85	
STDEV (PCT.)	5.7	4.6	2.3	2.4	
K-40 (PCI/G)	9.7	9.9	9.9	9.4	
STDEV (PCT.)	2.6	2.5	1.2	1.2	
CS-137 (PCI/G)	.910	.323	.049	.017	
STDEV (PCT.)	2.3	4.4	10.9	30.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01971	.00086
STDEV (PCT.)	3.1	25.7

KM21 CORPUS CHRISTI, TEXAS

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1438	3312	4314	14853	(694 SQ. CM.)
U-238 (PCI/G)	.56	.56	.53	.47	
STDEV (PCT.)	4.6	3.1	4.4	3.4	
TH-232 (PCI/G)	.57	.58	.49	.52	
STDEV (PCT.)	6.1	4.2	6.4	4.4	
K-40 (PCI/G)	8.3	8.0	7.4	7.3	
STDEV (PCT.)	2.7	1.9	2.7	1.9	
CS-137 (PCI/G)	.496	.429	.118	.017	
STDEV (PCT.)	3.2	2.4	8.2	31.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02127	.00195
STDEV (PCT.)	3.8	10.1

KM28 TUCSON, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2770	4481	4049	16983	(694 SQ. CM.)
U-238 (PCI/G)	.74	.76	.68	.69	
STDEV (PCT.)	4.1	3.9	4.2	2.0	
TH-232 (PCI/G)	1.00	1.03	.88	.90	
STDEV (PCT.)	4.5	4.4	4.9	2.3	
K-40 (PCI/G)	22.8	25.2	24.9	23.4	
STDEV (PCT.)	1.6	1.5	1.5	.8	
CS-137 (PCI/G)	.373	.423	.081	.010	
STDEV (PCT.)	4.2	3.7	14.3	56.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01964	.00171
STDEV (PCT.)	3.5	9.2

KM29 TUCSON, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1900	4857	4316	13953	(694 SQ. CM.)
U-238 (PCI/G)	.94	.55	1.01	1.02	
STDEV (PCT.)	3.5	2.3	1.6	1.6	
TH-232 (PCI/G)	1.17	.79	1.39	1.36	
STDEV (PCT.)	4.0	2.5	1.8	1.8	
K-40 (PCI/G)	20.5	31.3	27.9	28.4	
STDEV (PCT.)	1.7	.6	.7	.7	
CS-137 (PCI/G)	.671	.162	.046	.006	
STDEV (PCT.)	2.8	3.8	12.6	90.3	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

KM33 TUCSON, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2326	3851	3351	15915	(694 SQ. CM.)
U-238 (PCI/G)	.90	.83	.87	.92	
STDEV (PCT.)	3.6	1.8	1.7	1.7	
TH-232 (PCI/G)	1.07	1.03	1.14	1.19	
STDEV (PCT.)	4.3	2.1	2.0	1.9	
K-40 (PCI/G)	21.6	22.7	23.8	26.1	
STDEV (PCT.)	1.7	.8	.7	.7	
CS-137 (PCI/G)	.330	.250	.149	.033	
STDEV (PCT.)	4.6	2.8	4.2	17.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01574	.00278
STDEV (PCT.)	4.3	7.8

KS01 FREDONIA, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2614	4268	4355	16631	(694 SQ. CM.)
U-238 (PCI/G)	.76	1.10	1.05	1.23	
STDEV (PCT.)	3.9	1.9	1.5	1.6	
TH-232 (PCI/G)	.79	1.03	1.05	1.10	
STDEV (PCT.)	5.1	2.6	2.0	2.2	
K-40 (PCI/G)	13.9	16.4	16.3	17.0	
STDEV (PCT.)	2.1	1.2	.9	1.0	
CS-137 (PCI/G)	.519	.445	.200	.058	
STDEV (PCT.)	3.2	2.2	3.1	10.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02580	.00590
STDEV (PCT.)	5.4	6.5

KS05 NORTH RIM GRAND CANYON, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1884	3395	4924	14263	(694 SQ. CM.)
U-238 (PCI/G)	.95	.92	.96	1.08	
STDEV (PCT.)	3.5	3.2	3.2	2.9	
TH-232 (PCI/G)	.62	.61	.78	.83	
STDEV (PCT.)	6.6	6.0	5.0	4.8	
K-40 (PCI/G)	9.0	10.4	10.9	11.2	
STDEV (PCT.)	2.6	2.3	2.3	2.2	
CS-137 (PCI/G)	3.725	.182	.049	.040	
STDEV (PCT.)	1.0	6.4	19.9	22.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

KS07 MOCCASIN, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1681	3786	3910	12773
U-238 (PCI/G)	.29	.28	.24	.21
STDEV (PCT.)	7.6	7.1	8.3	9.0
TH-232 (PCI/G)	.19	.19	.20	.18
STDEV (PCT.)	14.7	14.1	13.0	13.8
K-40 (PCI/G)	13.8	13.9	14.2	13.4
STDEV (PCT.)	2.1	2.0	2.0	2.0
CS-137 (PCI/G)	.511	.490	.245	.034
STDEV (PCT.)	3.2	3.0	4.8	23.4

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05047	.00604
STDEV (PCT.)	3.2	5.7

KS10 NORTH RIM GRAND CANYON, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	781	1347	2640	10418	(694 SQ. CM.)
U-238 (PCI/G)	1.32	1.14	1.15	1.16	
STDEV (PCT.)	3.3	1.5	3.1	2.2	
TH-232 (PCI/G)	.85	.91	.93	.95	
STDEV (PCT.)	5.9	2.3	4.7	3.2	
K-40 (PCI/G)	12.4	11.4	11.6	11.8	
STDEV (PCT.)	2.5	1.1	2.4	1.7	
CS-137 (PCI/G)	7.033	1.292	.247	.044	
STDEV (PCT.)	.8	.9	5.7	16.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.21591	.00582
STDEV (PCT.)	2.6	6.5

KS21 LITTLEFIELD, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3257	4489	4202	12863	(694 SQ. CM.)
U-238 (PCI/G)	.70	.70	.70	.68	
STDEV (PCT.)	4.1	3.8	3.9	3.9	
TH-232 (PCI/G)	.90	.85	.77	.65	
STDEV (PCT.)	4.6	4.6	5.1	5.5	
K-40 (PCI/G)	14.2	13.3	13.5	13.5	
STDEV (PCT.)	2.0	2.0	2.0	2.0	
CS-137 (PCI/G)	.553	.489	.359	.170	
STDEV (PCT.)	3.1	3.2	4.0	6.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03652	.02001
STDEV (PCT.)	3.6	3.8

KS24 MESQUITE, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2766	3707	4484	14543	(694 SQ. CM.)
U-238 (PCI/G)	.80	.74	.72	.69	
STDEV (PCT.)	3.9	4.1	4.0	2.9	
TH-232 (PCI/G)	.77	.75	.72	.69	
STDEV (PCT.)	5.5	5.3	5.3	3.9	
K-40 (PCI/G)	14.3	14.3	13.7	13.1	
STDEV (PCT.)	2.1	2.1	2.1	1.5	
CS-137 (PCI/G)	.496	.420	.242	.077	
STDEV (PCT.)	3.4	3.7	5.4	9.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02392	.00840
STDEV (PCT.)	4.0	5.4

KS25 BUNKERVILLE, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2385	3646	3918	12979	(694 SQ. CM.)
U-238 (PCI/G)	1.21	1.21	1.27	1.09	
STDEV (PCT.)	3.1	2.2	1.4	3.3	
TH-232 (PCI/G)	.93	1.03	1.11	1.11	
STDEV (PCT.)	4.9	3.2	2.1	4.3	
K-40 (PCI/G)	17.1	17.6	18.8	19.1	
STDEV (PCT.)	2.0	1.3	.9	1.8	
CS-137 (PCI/G)	.808	.864	.703	.183	
STDEV (PCT.)	2.6	1.7	1.4	7.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05077	.02380
STDEV (PCT.)	3.6	3.9

KS26 BUNKERVILLE, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2938	4361	4187	12176	(694 SQ. CM.)
U-238 (PCI/G)	1.21	1.27	1.17	1.02	
STDEV (PCT.)	1.6	2.2	3.1	3.2	
TH-232 (PCI/G)	1.02	1.04	1.01	.96	
STDEV (PCT.)	2.3	3.3	4.6	4.6	
K-40 (PCI/G)	18.2	18.8	18.3	18.7	
STDEV (PCT.)	1.0	1.3	1.8	1.8	
CS-137 (PCI/G)	1.100	.848	.383	.105	
STDEV (PCT.)	1.1	1.8	4.1	10.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.06258	.01674
STDEV (PCT.)	3.5	4.3

KS27 LOGANDALE, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	3120	4315	4205	11935	(694 SQ. CM.)
U-238 (PCI/G)	1.13	1.18	1.12	1.26	
STDEV (PCT.)	1.5	1.1	2.2	1.5	
TH-232 (PCI/G)	1.09	1.17	1.23	1.41	
STDEV (PCT.)	2.0	1.5	2.8	1.8	
K-40 (PCI/G)	17.1	18.1	18.8	21.3	
STDEV (PCT.)	1.0	.7	1.3	.8	
CS-137 (PCI/G)	.172	.168	.166	.064	
STDEV (PCT.)	3.9	3.1	5.5	9.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

KS30 OVERTON, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2349	4112	4309	17012
U-238 (PCI/G)	.91	.72	.69	.70
STDEV (PCT.)	3.6	1.8	2.8	3.9
TH-232 (PCI/G)	.68	.60	.62	.72
STDEV (PCT.)	6.0	2.9	4.2	5.2
K-40 (PCI/G)	15.3	12.7	13.5	14.5
STDEV (PCT.)	2.0	1.1	1.4	2.0
CS-137 (PCI/G)	.586	.291	.151	.040
STDEV (PCT.)	3.0	2.3	5.2	24.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02779	.00440
STDEV (PCT.)	2.8	6.0

KS33 ALAMO, NEVADA

GAMMA ANALYSIS

DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2194	3750	3694	13931	(694 SQ. CM.)
U-238 (PCI/G)	1.56	1.69	1.55	1.39	
STDEV (PCT.)	2.6	2.4	2.5	1.3	
TH-232 (PCI/G)	1.45	1.56	1.57	1.77	
STDEV (PCT.)	3.6	3.4	3.4	1.3	
K-40 (PCI/G)	19.1	21.4	21.9	25.3	
STDEV (PCT.)	1.8	1.7	1.6	.6	
CS-137 (PCI/G)	.312	.233	.174	.042	
STDEV (PCT.)	4.9	6.1	7.6	12.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.05351	.01092
STDEV (PCT.)	5.2	4.9

KS34 ALAMO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2518	3744	4313	12910	(694 SQ. CM.)
U-238 (PCI/G)	1.14	1.15	1.27	1.43	
STDEV (PCT.)	3.1	3.0	2.9	2.7	
TH-232 (PCI/G)	1.45	1.55	1.39	1.51	
STDEV (PCT.)	3.5	3.4	3.7	3.5	
K-40 (PCI/G)	21.5	22.5	22.8	21.6	
STDEV (PCT.)	1.7	1.6	1.6	1.7	
CS-137 (PCI/G)	.203	.206	.191	.156	
STDEV (PCT.)	6.7	6.3	6.8	8.4	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

KS36 HIKO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2647	3626	3618	9309	(694 SQ. CM.)
U-238 (PCI/G)	1.94	1.86	1.75	.98	
STDEV (PCT.)	2.3	2.3	2.4	3.3	
TH-232 (PCI/G)	1.11	1.15	1.03	.93	
STDEV (PCT.)	4.3	4.1	4.5	4.6	
K-40 (PCI/G)	14.0	14.5	14.3	12.8	
STDEV (PCT.)	2.2	2.1	2.1	2.2	
CS-137 (PCI/G)	.375	.300	.268	.089	
STDEV (PCT.)	4.3	5.0	5.2	12.1	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04166	.01593
STDEV (PCT.)	4.1	4.8

MH02 ROSETTE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	5	
DRY WEIGHT (GMS)	797	1064	3221	3415	17319	(694 SQ. CM.)
U-238 (PCI/G)	1.40	1.82	1.84	1.82	1.64	
STDEV (PCT.)	2.9	2.4	2.4	2.4	2.4	
TH-232 (PCI/G)	1.42	1.70	1.80	1.72	1.60	
STDEV (PCT.)	3.7	3.4	3.2	3.3	3.4	
K-40 (PCI/G)	14.9	17.3	18.0	18.1	16.4	
STDEV (PCT.)	2.2	1.9	1.9	1.9	1.9	
CS-137 (PCI/G)	1.099	1.906	1.636	.411	.065	
STDEV (PCT.)	2.2	1.5	1.7	4.1	18.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.07118	.01446
STDEV (PCT.)	2.8	4.9

MH03 SNOWVILLE, UTAH

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1040	1428	3832	17458	(694 SQ. CM.)
U-238 (PCI/G)	1.19	1.33	1.15	.98	
STDEV (PCT.)	3.3	2.9	3.1	3.5	
TH-232 (PCI/G)	1.10	1.26	1.14	1.02	
STDEV (PCT.)	4.6	3.9	4.2	4.4	
K-40 (PCI/G)	16.1	17.8	17.0	15.3	
STDEV (PCT.)	2.0	1.9	1.9	2.1	
CS-137 (PCI/G)	4.561	.958	.255	.062	
STDEV (PCT.)	1.0	2.3	5.6	17.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.12775	.00441
STDEV (PCT.)	3.5	6.9

MH07 MALAD CITY, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2667	3248	3611	11139	(694 SQ. CM.)
U-238 (PCI/G)	1.37	1.51	1.42	1.53	
STDEV (PCT.)	1.6	1.3	2.0	1.3	
TH-232 (PCI/G)	1.59	1.85	1.80	1.84	
STDEV (PCT.)	1.9	1.5	2.2	1.5	
K-40 (PCI/G)	20.8	22.6	23.1	23.0	
STDEV (PCT.)	1.0	.8	1.1	.8	
CS-137 (PCI/G)	.784	.505	.276	.081	
STDEV (PCT.)	1.5	1.8	4.0	8.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03944	.00871
STDEV (PCT.)	5.1	9.9

MH11 BURLEY, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2356	3883	3246	9834
U-238 (PCI/G)	1.71	1.89	1.92	1.90
STDEV (PCT.)	2.5	1.7	2.4	2.4
TH-232 (PCI/G)	1.99	2.13	2.21	2.24
STDEV (PCT.)	3.0	2.1	2.8	2.8
K-40 (PCI/G)	23.0	24.7	24.5	24.9
STDEV (PCT.)	2.2	1.1	1.6	1.6
CS-137 (PCI/G)	.487	.279	.433	.062
STDEV (PCT.)	3.8	4.2	4.1	21.4

**** NO PLUTONIUM ANALYSIS PERFORMED ****

MH12 BURLEY, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	972	1715	3506	15605
U-238 (PCI/G)	.83	.96	.95	.99
STDEV (PCT.)	4.3	3.5	3.6	1.3
TH-232 (PCI/G)	.78	.89	.95	.97
STDEV (PCT.)	5.8	5.0	4.7	1.7
K-40 (PCI/G)	15.4	16.6	18.4	18.7
STDEV (PCT.)	2.2	1.9	1.9	.7
CS-137 (PCI/G)	1.739	1.233	.288	.008
STDEV (PCT.)	1.7	1.7	4.9	47.8

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.09934	.00076
STDEV (PCT.)	2.9	14.7

MH14 TWIN FALLS, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2495	3871	3887	12455
U-238 (PCI/G)	.97	1.05	1.19	1.12
STDEV (PCT.)	3.5	2.3	3.0	1.5
TH-232 (PCI/G)	1.01	1.08	1.22	1.13
STDEV (PCT.)	4.5	3.0	3.9	1.9
K-40 (PCI/G)	14.8	14.7	15.0	15.4
STDEV (PCT.)	2.1	1.4	2.0	1.0
CS-137 (PCI/G)	.567	.545	.260	.043
STDEV (PCT.)	3.0	2.3	5.5	12.6

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01819	.00446
STDEV (PCT.)	4.5	8.4

MH17 FILER, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3126	3992	4419	12338
U-238 (PCI/G)	1.15	1.18	1.23	1.20
STDEV (PCT.)	3.1	3.0	2.9	1.4
TH-232 (PCI/G)	1.12	1.21	1.24	1.18
STDEV (PCT.)	4.3	4.0	3.8	1.9
K-40 (PCI/G)	16.1	16.4	17.1	15.8
STDEV (PCT.)	2.0	2.0	1.9	1.0
CS-137 (PCI/G)	.511	.331	.183	.054
STDEV (PCT.)	3.4	4.6	6.9	10.7

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02102	.00476
STDEV (PCT.)	4.3	6.9

MH19 MERIDIAN, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2493	3413	3603	10262
U-238 (PCI/G)	1.08	1.01	1.16	1.30
STDEV (PCT.)	3.2	3.5	3.1	1.4
TH-232 (PCI/G)	1.40	1.16	1.35	1.41
STDEV (PCT.)	3.6	4.2	3.7	1.7
K-40 (PCI/G)	15.5	15.5	16.6	16.7
STDEV (PCT.)	2.0	2.1	2.0	1.0
CS-137 (PCI/G)	.879	.233	.123	.044
STDEV (PCT.)	2.4	6.0	10.1	13.6

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02561	.00318
STDEV (PCT.)	4.2	6.2

MH22 BOISE, IDAHO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1879	4290	4695	14356
U-238 (PCI/G)	.73	.64	.57	.50
STDEV (PCT.)	3.0	3.0	3.3	1.4
TH-232 (PCI/G)	.91	.70	.65	.63
STDEV (PCT.)	3.4	3.9	4.2	1.7
K-40 (PCI/G)	19.0	21.8	23.5	23.2
STDEV (PCT.)	1.2	1.1	1.1	.4
CS-137 (PCI/G)	1.775	.209	.063	.013
STDEV (PCT.)	1.1	4.2	11.1	22.9

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03420	.00264
STDEV (PCT.)	4.8	9.5

MH25 JORDAN VALLEY, OREGON

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1664	2745	2877	10424
U-238 (PCI/G)	.67	.76	.72	.76
STDEV (PCT.)	4.7	2.5	4.4	2.0
TH-232 (PCI/G)	.62	.69	.60	.68
STDEV (PCT.)	6.4	3.5	6.5	2.9
K-40 (PCI/G)	15.3	17.1	16.5	16.6
STDEV (PCT.)	2.1	1.2	2.0	1.0
CS-137 (PCI/G)	1.147	.555	.287	.071
STDEV (PCT.)	2.1	1.9	5.0	7.8

**** NO PLUTONIUM ANALYSIS PERFORMED ****

MH28 HINES, OREGON

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1580	2489	2388	10509
U-238 (PCI/G)	.46	.60	.62	.63
STDEV (PCT.)	6.2	4.7	3.3	4.6
TH-232 (PCI/G)	.49	.59	.59	.58
STDEV (PCT.)	7.3	6.3	4.4	6.4
K-40 (PCI/G)	12.3	13.3	15.3	14.5
STDEV (PCT.)	2.4	2.3	1.4	2.1
CS-137 (PCI/G)	.774	.647	.255	.047
STDEV (PCT.)	2.6	2.9	3.7	19.0

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03333	.00456
STDEV (PCT.)	3.2	7.4

MH29 BASQUE STATION, OREGON

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2156	3178	3184	11949
U-238 (PCI/G)	1.00	1.10	1.15	1.26
STDEV (PCT.)	3.5	3.2	3.1	2.8
TH-232 (PCI/G)	.98	.93	1.01	1.15
STDEV (PCT.)	4.6	4.8	4.5	4.1
K-40 (PCI/G)	17.2	18.3	19.0	20.8
STDEV (PCT.)	1.9	1.8	1.8	1.7
CS-137 (PCI/G)	.592	.558	.354	.071
STDEV (PCT.)	3.1	3.1	4.3	16.1

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02705	.00510
STDEV (PCT.)	4.2	5.2

NM01 ESTANCIA, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1859	3095	2953	12535	(694 SQ. CM.)
U-238 (PCI/G)	.64	.71	.76	.70	
STDEV (PCT.)	4.4	3.9	3.7	4.0	
TH-232 (PCI/G)	.59	.64	.70	.68	
STDEV (PCT.)	6.0	5.7	5.2	5.5	
K-40 (PCI/G)	11.5	12.5	13.1	13.9	
STDEV (PCT.)	2.3	2.1	2.1	2.0	
CS-137 (PCI/G)	.303	.355	.350	.232	
STDEV (PCT.)	4.9	4.2	4.2	5.7	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM02 MORIARTY, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2490	4822	4070	15791	(694 SQ. CM.)
U-238 (PCI/G)	.92	.95	.98	.90	
STDEV (PCT.)	3.4	3.2	3.1	3.4	
TH-232 (PCI/G)	1.04	1.00	.98	1.04	
STDEV (PCT.)	4.3	4.3	4.5	4.2	
K-40 (PCI/G)	18.6	19.2	18.8	18.7	
STDEV (PCT.)	1.7	1.7	1.7	1.7	
CS-137 (PCI/G)	1.326	.147	.024	-.007	
STDEV (PCT.)	1.9	8.6	43.8	-157.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02673	.00015
STDEV (PCT.)	3.9	54.7

NM03 BELEN, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2168	4395	3510	16840	(694 SQ. CM.)
U-238 (PCI/G)	.86	.95	1.08	1.06	
STDEV (PCT.)	3.7	3.5	1.6	1.5	
TH-232 (PCI/G)	.80	.95	.99	1.04	
STDEV (PCT.)	5.3	4.7	2.2	2.1	
K-40 (PCI/G)	15.9	17.6	18.6	19.2	
STDEV (PCT.)	2.0	1.9	.9	.9	
CS-137 (PCI/G)	.427	.254	.102	.030	
STDEV (PCT.)	3.9	5.9	6.4	19.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01986	.00280
STDEV (PCT.)	4.5	9.0

NM04 LAS CRUCES, NEW MEXICO

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2732	4587	4140	15723	(694 SQ. CM.)
U-238 (PCI/G)	.92	.90	.84	.85	
STDEV (PCT.)	3.4	3.4	1.7	1.7	
TH-232 (PCI/G)	.91	1.00	.93	.92	
STDEV (PCT.)	4.6	4.3	2.1	2.2	
K-40 (PCI/G)	16.8	18.7	18.6	18.7	
STDEV (PCT.)	1.9	1.7	.8	.9	
CS-137 (PCI/G)	.252	.138	.060	.010	
STDEV (PCT.)	5.6	9.2	9.6	58.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01046	.00127
STDEV (PCT.)	5.0	12.4

NM05 SOLOMONVILLE, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1777	2930	2152	9061	(694 SQ. CM.)
U-238 (PCI/G)	.85	.97	1.01	1.13	
STDEV (PCT.)	4.0	3.7	3.6	3.2	
TH-232 (PCI/G)	1.22	1.47	1.39	1.51	
STDEV (PCT.)	4.1	3.5	3.8	3.5	
K-40 (PCI/G)	17.8	18.8	19.1	22.9	
STDEV (PCT.)	2.0	1.9	1.9	1.7	
CS-137 (PCI/G)	.422	.363	.214	.039	
STDEV (PCT.)	4.2	4.8	6.9	32.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01865	.00102
STDEV (PCT.)	4.5	12.6

NM06 ROSWELL, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1754	3750	3248	12580	(694 SQ. CM.)
U-238 (PCI/G)	1.10	1.09	1.25	1.30	
STDEV (PCT.)	3.1	3.1	2.9	3.1	
TH-232 (PCI/G)	.85	1.00	1.04	1.20	
STDEV (PCT.)	5.0	4.5	4.4	4.1	
K-40 (PCI/G)	14.7	17.1	17.0	18.9	
STDEV (PCT.)	2.1	1.9	1.9	1.9	
CS-137 (PCI/G)	.526	.434	.160	.034	
STDEV (PCT.)	3.4	3.8	8.5	35.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02269	.00369
STDEV (PCT.)	4.0	7.6

NM07 SAFFORD, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1497	3655	3335	15226	(694 SQ. CM.)
U-238 (PCI/G)	.64	.73	.70	.70	
STDEV (PCT.)	4.7	4.0	4.3	2.0	
TH-232 (PCI/G)	1.00	1.18	1.14	1.13	
STDEV (PCT.)	4.4	3.9	4.1	1.9	
K-40 (PCI/G)	17.0	21.2	23.4	22.6	
STDEV (PCT.)	1.9	1.6	1.6	.8	
CS-137 (PCI/G)	.307	.296	.222	.034	
STDEV (PCT.)	5.0	5.1	6.3	17.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01369	.00325
STDEV (PCT.)	4.5	7.9

NM08 SILVER CITY, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2284	3680	3572	15614	(694 SQ. CM.)
U-238 (PCI/G)	.82	.86	.84	.69	
STDEV (PCT.)	3.8	3.5	3.6	4.1	
TH-232 (PCI/G)	.95	1.03	1.04	1.06	
STDEV (PCT.)	4.7	4.2	4.2	4.1	
K-40 (PCI/G)	22.4	22.6	23.0	22.8	
STDEV (PCT.)	1.6	1.6	1.5	1.5	
CS-137 (PCI/G)	.391	.374	.213	.061	
STDEV (PCT.)	4.3	4.3	6.3	18.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01915	.00485
STDEV (PCT.)	4.2	7.4

NM09 SOCORRO, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2370	3682	2950	13663	(694 SQ. CM.)
U-238 (PCI/G)	1.12	1.04	1.07	1.03	
STDEV (PCT.)	3.0	3.3	3.2	1.6	
TH-232 (PCI/G)	.98	1.03	1.08	1.09	
STDEV (PCT.)	4.6	4.4	4.3	2.1	
K-40 (PCI/G)	22.3	23.5	26.2	28.0	
STDEV (PCT.)	1.6	1.6	1.5	.7	
CS-137 (PCI/G)	.295	.243	.178	.059	
STDEV (PCT.)	5.1	6.0	7.6	10.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01827	.00615
STDEV (PCT.)	4.2	5.9

NM10 CARLSBAD, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1535	3003	3012	12932	(694 SQ. CM.)
U-238 (PCI/G)	1.04	1.11	1.10	.77	
STDEV (PCT.)	3.1	3.0	1.5	1.7	
TH-232 (PCI/G)	.69	.87	.90	.65	
STDEV (PCT.)	5.5	4.8	2.3	2.7	
K-40 (PCI/G)	13.0	14.0	15.0	12.2	
STDEV (PCT.)	2.2	2.0	1.0	1.0	
CS-137 (PCI/G)	.404	.308	.145	.008	
STDEV (PCT.)	4.0	4.8	4.4	66.4	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM11 PORTALES, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2346	4197	4184	16879	(694 SQ. CM.)
U-238 (PCI/G)	.70	.75	.76	.83	
STDEV (PCT.)	4..	3.7	3.6	3.4	
TH-232 (PCI/G)	.67	.65	.83	.78	
STDEV (PCT.)	5.7	5.9	4.7	4.8	
K-40 (PCI/G)	11.6	12.5	12.9	12.8	
STDEV (PCT.)	2.3	2.1	2.0	2.0	
CS-137 (PCI/G)	.394	.377	.274	.054	
STDEV (PCT.)	4.0	4.0	4.9	19.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01872	.00627
STDEV (PCT.)	3.9	6.6

NM12 TUCUMCARI, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2303	3564	3868	14971	(694 SQ. CM.)
U-238 (PCI/G)	.51	.53	.49	.53	
STDEV (PCT.)	4.9	4.6	4.9	4.7	
TH-232 (PCI/G)	.38	.41	.47	.52	
STDEV (PCT.)	8.3	7.6	6.9	6.5	
K-40 (PCI/G)	9.4	10.1	10.2	11.0	
STDEV (PCT.)	2.5	2.3	2.3	2.3	
CS-137 (PCI/G)	.332	.344	.250	.196	
STDEV (PCT.)	4.3	4.1	5.0	6.2	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM13 SOCORRO, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1794	3636	2703	11284	(694 SQ. CM.)
U-238 (PCI/G)	.86	.95	.91	.87	
STDEV (PCT.)	3.5	3.4	1.6	1.8	
TH-232 (PCI/G)	.79	.89	1.08	1.08	
STDEV (PCT.)	5.2	4.9	2.1	2.1	
K-40 (PCI/G)	22.8	27.0	32.9	31.0	
STDEV (PCT.)	1.5	1.4	.6	.6	
CS-137 (PCI/G)	.355	.345	.146	.029	
STDEV (PCT.)	4.3	4.6	4.7	21.4	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM14 SANTE FE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1950	3344	3091	13255	(694 SQ. CM.)
U-238 (PCI/G)	.57	.54	.57	.52	
STDEV (PCT.)	4.5	4.6	4.3	4.7	
TH-232 (PCI/G)	.51	.53	.50	.52	
STDEV (PCT.)	6.9	6.7	6.7	6.5	
K-40 (PCI/G)	13.8	15.1	16.7	17.1	
STDEV (PCT.)	2.0	1.9	1.8	1.7	
CS-137 (PCI/G)	.831	.430	.173	.040	
STDEV (PCT.)	2.4	3.6	6.7	23.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM15 SANTE FE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1825	2980	3017	9710	(694 SQ. CM.)
U-238 (PCI/G)	.67	.66	.67	.56	
STDEV (PCT.)	4.2	4.0	3.9	4.5	
TH-232 (PCI/G)	.52	.58	.58	.52	
STDEV (PCT.)	6.9	6.2	6.2	6.5	
K-40 (PCI/G)	13.7	16.0	17.2	15.7	
STDEV (PCT.)	2.1	1.9	1.8	1.9	
CS-137 (PCI/G)	.843	.233	.116	.028	
STDEV (PCT.)	2.4	5.6	9.5	34.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02065	.00337
STDEV (PCT.)	3.8	7.9

NM16 SANTE FE, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2641	4186	2912	11417	(694 SQ. CM.)
U-238 (PCI/G)	.80	.90	.90	.80	
STDEV (PCT.)	3.7	3.4	3.4	3.7	
TH-232 (PCI/G)	.88	1.01	.93	.84	
STDEV (PCT.)	4.7	4.2	4.7	4.9	
K-40 (PCI/G)	17.1	17.0	18.4	20.0	
STDEV (PCT.)	1.8	1.8	1.7	1.7	
CS-137 (PCI/G)	.465	.274	.170	.050	
STDEV (PCT.)	3.7	5.2	7.5	22.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01685	.00433
STDEV (PCT.)	4.2	8.4

NM17 RATON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1687	3384	3352	11084	(694 SQ. CM.)
U-238 (PCI/G)	.98	.93	1.01	1.10	
STDEV (PCT.)	3.6	3.5	3.3	3.1	
TH-232 (PCI/G)	.98	1.21	1.20	1.24	
STDEV (PCT.)	4.7	3.9	3.9	3.8	
K-40 (PCI/G)	14.1	16.2	16.5	17.4	
STDEV (PCT.)	2.2	2.0	1.9	1.9	
CS-137 (PCI/G)	1.875	.240	.135	.044	
STDEV (PCT.)	1.6	6.2	9.8	27.5	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03740	.00626
STDEV (PCT.)	3.9	5.7

NM18 CIMARRON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1955	3585	3621	14183	(694 SQ. CM.)
U-238 (PCI/G)	1.06	1.07	1.08	.91	
STDEV (PCT.)	3.3	3.3	3.1	3.6	
TH-232 (PCI/G)	.80	.89	.96	.85	
STDEV (PCT.)	5.2	4.9	4.6	5.1	
K-40 (PCI/G)	17.4	18.2	19.2	17.9	
STDEV (PCT.)	1.9	1.9	1.8	1.8	
CS-137 (PCI/G)	.453	.405	.313	.091	
STDEV (PCT.)	3.8	4.1	5.0	13.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02005	.00691
STDEV (PCT.)	4.0	5.8

NM19 CHAMA, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2002	3187	3347	12811	(694 SQ. CM.)
U-238 (PCI/G)	.77	.85	.84	.86	
STDEV (PCT.)	4.2	3.8	3.8	3.8	
TH-232 (PCI/G)	.74	.84	.84	.81	
STDEV (PCT.)	5.6	5.1	5.0	5.2	
K-40 (PCI/G)	17.0	16.3	17.7	16.0	
STDEV (PCT.)	1.9	2.0	1.9	2.0	
CS-137 (PCI/G)	1.243	.414	.184	.076	
STDEV (PCT.)	2.0	4.1	7.5	15.4	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03734	.00314
STDEV (PCT.)	3.6	5.9

NM20 FARMINGTON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2351	4148	3243	6013	(694 SQ. CM.)
U-238 (PCI/G)	1.67	1.60	1.61	1.42	
STDEV (PCT.)	2.3	2.4	2.3	2.6	
TH-232 (PCI/G)	1.14	1.11	1.13	1.03	
STDEV (PCT.)	4.1	4.2	4.0	4.5	
K-40 (PCI/G)	17.1	17.7	18.3	18.2	
STDEV (PCT.)	1.8	1.8	1.7	1.8	
CS-137 (PCI/G)	.440	.380	.283	.154	
STDEV (PCT.)	3.9	4.3	5.1	8.8	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM21 FARMINGTON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1737	3789	3604	10474	(694 SQ. CM.)
U-238 (PCI/G)	.95	.83	.80	.69	
STDEV (PCT.)	3.3	3.5	3.5	4.0	
TH-232 (PCI/G)	.74	.77	.80	.83	
STDEV (PCT.)	5.4	5.2	5.0	4.9	
K-40 (PCI/G)	20.6	23.4	23.1	25.7	
STDEV (PCT.)	1.7	1.5	1.5	1.4	
CS-137 (PCI/G)	.802	.218	.095	.033	
STDEV (PCT.)	2.5	6.0	11.9	31.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02330	.00337
STDEV (PCT.)	4.0	7.7

NM22 FARMINGTON, NEW MEXICO

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2539	3956	3597	14425	(694 SQ. CM.)
U-238 (PCI/G)	1.35	1.31	1.21	1.06	
STDEV (PCT.)	1.8	2.7	2.8	3.1	
TH-232 (PCI/G)	.97	.91	1.02	1.01	
STDEV (PCT.)	3.2	4.7	4.3	4.4	
K-40 (PCI/G)	18.2	18.0	19.0	20.3	
STDEV (PCT.)	1.3	1.8	1.7	1.7	
CS-137 (PCI/G)	.341	.296	.177	.071	
STDEV (PCT.)	3.2	5.0	7.5	15.9	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01659	.00447
STDEV (PCT.)	4.3	6.5

NM23 TEMPE, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2189	3906	3807	16426	(694 SQ. CM.)
U-238 (PCI/G)	.78	.87	.96	.99	
STDEV (PCT.)	3.8	3.6	3.3	1.7	
TH-232 (PCI/G)	.79	.96	.96	1.15	
STDEV (PCT.)	5.1	4.4	4.5	1.9	
K-40 (PCI/G)	15.3	15.1	16.8	18.8	
STDEV (PCT.)	2.0	2.0	1.9	.9	
CS-137 (PCI/G)	.129	.199	.152	.028	
STDEV (PCT.)	9.5	6.6	8.4	21.3	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM24 TEMPE, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1736	3558	3704	15846	(694 SQ. CM.)
U-238 (PCI/G)	.86	.86	.85	.94	
STDEV (PCT.)	3.8	3.8	3.8	1.7	
TH-232 (PCI/G)	.92	.97	.98	1.01	
STDEV (PCT.)	4.8	4.7	4.5	2.2	
K-40 (PCI/G)	16.8	18.8	18.5	19.4	
STDEV (PCT.)	2.0	1.8	1.8	.9	
CS-137 (PCI/G)	.204	.158	.240	.032	
STDEV (PCT.)	7.1	8.4	6.0	18.6	

**** NO PLUTONIUM ANALYSIS PERFORMED ****

NM25 MESA, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2842	3840	3670	8948	(694 SQ. CM.)
U-238 (PCI/G)	.93	.97	.96	.87	
STDEV (PCT.)	3.7	3.6	3.6	3.9	
TH-232 (PCI/G)	1.15	1.07	1.18	1.09	
STDEV (PCT.)	4.2	4.4	4.0	4.4	
K-40 (PCI/G)	19.9	20.1	20.3	20.5	
STDEV (PCT.)	1.8	1.8	1.8	1.8	
CS-137 (PCI/G)	.286	.242	.139	.043	
STDEV (PCT.)	5.5	6.2	9.8	27.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01250	.00351
STDEV (PCT.)	4.8	7.8

NM26 LITCHFIELD PARK, ARIZONA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2251	3456	3594	15564	(694 SQ. CM.)
U-238 (PCI/G)	.70	.78	.78	.77	
STDEV (PCT.)	4.3	3.7	1.8	1.8	
TH-232 (PCI/G)	.79	.83	.85	.82	
STDEV (PCT.)	5.3	5.0	2.3	2.4	
K-40 (PCI/G)	19.0	21.7	21.9	22.1	
STDEV (PCT.)	1.8	1.6	.8	.8	
CS-137 (PCI/G)	.174	.180	.109	.023	
STDEV (PCT.)	7.8	7.3	5.7	23.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.00839	.00200
STDEV (PCT.)	5.3	10.0

RB01 SCOTTSBLUFF, NEBRASKA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3175	4603	4624	13592
U-238 (PCI/G)	.84	.78	.76	.74
STDEV (PCT.)	3.5	2.6	3.8	3.8
TH-232 (PCI/G)	.96	.96	.90	.77
STDEV (PCT.)	4.5	3.1	4.7	5.2
K-40 (PCI/G)	19.6	20.5	20.1	22.0
STDEV (PCT.)	1.7	1.1	1.6	1.6
CS-137 (PCI/G)	.551	.453	.287	.042
STDEV (PCT.)	3.0	2.5	4.7	24.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02049	.00596
STDEV (PCT.)	4.3	5.0

RB08 RAPID CITY, SOUTH DAKOTA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2746	4032	4006	16030	(694 SQ. CM.)
U-238 (PCI/G)	1.09	1.16	1.12	1.10	
STDEV (PCT.)	3.2	3.0	3.1	3.1	
TH-232 (PCI/G)	1.02	1.00	.95	.88	
STDEV (PCT.)	4.4	4.6	4.7	4.9	
K-40 (PCI/G)	14.3	14.1	14.6	14.1	
STDEV (PCT.)	2.1	2.1	2.1	2.1	
CS-137 (PCI/G)	.710	.685	.561	.307	
STDEV (PCT.)	2.7	2.8	3.2	4.6	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03065	.01745
STDEV (PCT.)	2.8	3.5

RB11 RAPID CITY, SOUTH DAKOTA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1359	1497	3904	15688
U-238 (PCI/G)	1.09	1.23	1.16	1.14
STDEV (PCT.)	3.2	2.9	3.0	3.0
TH-232 (PCI/G)	.98	1.08	1.06	1.22
STDEV (PCT.)	4.6	4.3	4.4	3.9
K-40 (PCI/G)	16.6	17.7	17.6	17.7
STDEV (PCT.)	1.9	1.9	1.8	1.8
CS-137 (PCI/G)	.791	.779	.574	.502
STDEV (PCT.)	2.6	2.6	3.1	3.3

**** NO PLUTONIUM ANALYSIS PERFORMED ****

RB16 BILLINGS, MONTANA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3123	4103	4359	13662
U-238 (PCI/G)	.78	.83	.84	.84
STDEV (PCT.)	3.7	3.6	3.6	3.6
TH-232 (PCI/G)	.79	.91	.92	.92
STDEV (PCT.)	5.2	4.6	4.5	4.5
K-40 (PCI/G)	15.8	17.2	16.7	16.7
STDEV (PCT.)	1.9	1.8	1.8	1.9
CS-137 (PCI/G)	.959	.291	.196	.054
STDEV (PCT.)	2.2	4.7	6.5	19.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02611	.00380
STDEV (PCT.)	3.6	7.1

RM02 WINNEMUCCA, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2484	3965	4425	12396
U-238 (PCI/G)	1.13	1.22	1.20	1.19
STDEV (PCT.)	3.1	2.9	2.0	1.4
TH-232 (PCI/G)	1.19	1.16	1.33	1.33
STDEV (PCT.)	4.0	4.1	2.6	1.7
K-40 (PCI/G)	19.4	20.0	22.1	21.4
STDEV (PCT.)	1.8	1.7	1.1	.8
CS-137 (PCI/G)	.725	.326	.125	.049
STDEV (PCT.)	2.6	4.4	6.7	11.2

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02527	.00372
STDEV (PCT.)	3.3	6.7

RM06 BATTLE MOUNTAIN, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3118	3939	4143	12835
U-238 (PCI/G)	1.27	1.43	1.35	1.39
STDEV (PCT.)	2.9	2.6	2.8	1.3
TH-232 (PCI/G)	1.26	1.32	1.33	1.40
STDEV (PCT.)	4.0	3.8	3.8	1.8
K-40 (PCI/G)	23.3	24.8	25.3	25.0
STDEV (PCT.)	1.6	1.5	1.5	.7
CS-137 (PCI/G)	.570	.346	.129	.025
STDEV (PCT.)	3.1	4.4	9.8	22.8

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01968	.00340
STDEV (PCT.)	3.2	5.9

RM08 CARLIN, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1382	3262	3510	9807
U-238 (PCI/G)	1.54	1.46	1.31	1.39
STDEV (PCT.)	2.8	1.9	2.9	2.8
TH-232 (PCI/G)	.96	1.24	1.29	1.11
STDEV (PCT.)	5.1	2.9	3.8	4.3
K-40 (PCI/G)	14.1	18.2	18.0	16.3
STDEV (PCT.)	2.2	1.3	1.9	2.0
CS-137 (PCI/G)	2.892	.157	.038	.019
STDEV (PCT.)	1.3	6.1	28.2	56.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04189	.00090
STDEV (PCT.)	5.2	13.9

RM10 ELKO, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2871	3891	3738	10649
U-238 (PCI/G)	1.22	1.18	1.15	1.09
STDEV (PCT.)	2.2	3.0	3.0	3.1
TH-232 (PCI/G)	1.22	1.15	1.19	1.13
STDEV (PCT.)	2.8	4.1	4.0	4.1
K-40 (PCI/G)	18.2	17.9	17.5	16.5
STDEV (PCT.)	1.3	1.8	1.9	1.9
CS-137 (PCI/G)	.422	.358	.273	.091
STDEV (PCT.)	2.8	4.4	5.1	12.5

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.01915	.00629
STDEV (PCT.)	4.7	10.0

RM12 WELLS, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2701	3798	4030	10771
U-238 (PCI/G)	1.36	1.35	1.34	1.42
STDEV (PCT.)	2.9	2.7	2.8	2.0
TH-232 (PCI/G)	1.49	1.40	1.39	1.63
STDEV (PCT.)	3.6	3.6	3.7	2.4
K-40 (PCI/G)	19.2	19.0	19.4	20.8
STDEV (PCT.)	1.8	1.8	1.8	1.2
CS-137 (PCI/G)	.965	.259	.134	.075
STDEV (PCT.)	2.3	5.6	9.5	11.4

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03013	.00515
STDEV (PCT.)	7.4	9.9

RM14 PIOCHE, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1581	3717	5464	10775	(694 SQ. CM.)
U-238 (PCI/G)	1.25	1.25	1.36	1.32	
STDEV (PCT.)	3.0	3.0	2.8	3.0	
TH-232 (PCI/G)	1.33	1.98	2.03	2.16	
STDEV (PCT.)	3.8	2.9	2.9	2.9	
K-40 (PCI/G)	23.7	24.0	25.9	25.8	
STDEV (PCT.)	1.6	1.6	1.5	1.6	
CS-137 (PCI/G)	.511	.533	.154	.032	
STDEV (PCT.)	3.5	3.4	8.8	39.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03957	.00730
STDEV (PCT.)	3.4	5.3

RM19 PANACA, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2543	3550	4268	12389	(694 SQ. CM.)
U-238 (PCI/G)	2.57	2.91	3.19	2.89	
STDEV (PCT.)	.9	.8	1.7	1.8	
TH-232 (PCI/G)	1.18	1.28	1.31	1.32	
STDEV (PCT.)	2.1	1.8	4.1	4.0	
K-40 (PCI/G)	21.0	22.1	21.9	22.9	
STDEV (PCT.)	.8	.7	1.8	1.6	
CS-137 (PCI/G)	.302	.290	.225	.112	
STDEV (PCT.)	2.6	2.4	6.8	11.7	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02035	.00792
STDEV (PCT.)	3.6	4.4

RM21 CALIENTE, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2754	3660	4360	12929	(694 SQ. CM.)
U-238 (PCI/G)	1.22	1.36	1.42	1.37	
STDEV (PCT.)	3.0	2.7	2.8	1.3	
TH-232 (PCI/G)	1.87	1.83	2.13	2.28	
STDEV (PCT.)	3.0	3.1	2.8	1.3	
K-40 (PCI/G)	25.7	26.6	28.2	29.5	
STDEV (PCT.)	1.5	1.4	1.4	.6	
CS-137 (PCI/G)	.520	.361	.119	.024	
STDEV (PCT.)	3.4	4.3	11.4	25.2	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02875	.00399
STDEV (PCT.)	3.7	10.0

SA02 WICHITA, KANSAS

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1975	3965	4085	13897
U-238 (PCI/G)	.70	.78	.77	.66
STDEV (PCT.)	4.2	3.7	3.7	4.1
TH-232 (PCI/G)	.90	.92	.88	.86
STDEV (PCT.)	4.8	4.7	4.8	4.7
K-40 (PCI/G)	22.3	23.5	22.9	24.2
STDEV (PCT.)	1.6	1.5	1.5	1.5
CS-137 (PCI/G)	.571	.525	.358	.096
STDEV (PCT.)	3.0	3.1	4.0	11.4

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02356	.00626
STDEV (PCT.)	4.1	5.8

SA07 WICHITA, KANSAS

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2661	3448	3344	10001
U-238 (PCI/G)	.83	.87	.81	.89
STDEV (PCT.)	3.9	3.7	3.9	3.8
TH-232 (PCI/G)	1.24	1.19	1.32	1.44
STDEV (PCT.)	3.9	4.0	3.7	3.5
K-40 (PCI/G)	15.9	15.6	15.3	15.7
STDEV (PCT.)	2.0	2.0	2.0	2.1
CS-137 (PCI/G)	.873	.417	.245	.082
STDEV (PCT.)	2.4	3.9	5.7	14.4

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02636	.00522
STDEV (PCT.)	3.6	6.8

SA19 DES MOINES, IOWA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2852	4090	3723	11247
U-238 (PCI/G)	1.07	1.08	1.10	1.13
STDEV (PCT.)	3.2	3.2	3.1	3.1
TH-232 (PCI/G)	.95	1.00	1.13	1.02
STDEV (PCT.)	4.7	4.5	4.0	4.3
K-40 (PCI/G)	15.0	15.1	15.6	15.2
STDEV (PCT.)	2.0	2.0	1.9	2.0
CS-137 (PCI/G)	.647	.633	.346	.117
STDEV (PCT.)	2.9	2.9	4.4	10.0

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02505	.00763
STDEV (PCT.)	3.1	4.6

SA20 ST. LOUIS, MISSOURI

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2471	3843	3430	12453
U-238 (PCI/G)	1.04	1.19	1.32	1.22
STDEV (PCT.)	3.3	2.9	2.8	3.0
TH-232 (PCI/G)	.95	1.07	1.09	1.04
STDEV (PCT.)	4.6	4.2	4.2	4.4
K-40 (PCI/G)	14.9	16.1	16.7	16.6
STDEV (PCT.)	2.0	1.9	1.9	1.9
CS-137 (PCI/G)	.614	.634	.335	.118
STDEV (PCT.)	3.0	2.9	4.5	10.1

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02815	.00554
STDEV (PCT.)	2.8	6.3

SA26 ST. LOUIS, MISSOURI

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	3150	3845	4188	11872
U-238 (PCI/G)	1.14	1.14	1.08	1.15
STDEV (PCT.)	3.1	3.1	3.1	3.0
TH-232 (PCI/G)	.98	1.01	1.03	1.00
STDEV (PCT.)	4.5	4.5	4.3	4.6
K-40 (PCI/G)	15.5	15.7	15.8	16.2
STDEV (PCT.)	2.0	2.0	1.9	2.0
CS-137 (PCI/G)	.645	.651	.382	.126
STDEV (PCT.)	2.9	2.9	4.0	9.6

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02936	.00890
STDEV (PCT.)	2.8	4.2

SH05 LAS VEGAS, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2040	3900	3777	11818
U-238 (PCI/G)	1.18	1.17	1.27	1.25
STDEV (PCT.)	2.9	2.8	2.8	1.3
TH-232 (PCI/G)	.58	.59	.57	.66
STDEV (PCT.)	6.3	6.3	6.5	2.7
K-40 (PCI/G)	8.7	9.3	9.3	10.0
STDEV (PCT.)	2.7	2.5	2.6	1.2
CS-137 (PCI/G)	.497	.203	.008	.004
STDEV (PCT.)	3.3	6.0	105.7	120.6

**** NO PLUTONIUM ANALYSIS PERFORMED ****

SH07 LAS VEGAS, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	1419	4007	3775	11117
U-238 (PCI/G)	.94	1.04	1.13	1.02
STDEV (PCT.)	3.4	3.1	3.0	1.2
TH-232 (PCI/G)	.56	.65	.70	.62
STDEV (PCT.)	6.5	5.8	5.7	2.2
K-40 (PCI/G)	9.6	10.5	10.0	10.0
STDEV (PCT.)	2.6	2.4	2.5	.9
CS-137 (PCI/G)	.257	.310	.158	.026
STDEV (PCT.)	5.0	4.5	7.5	14.9

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03086	.00707
STDEV (PCT.)	3.0	4.4

SH10 HENDERSON, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4
DRY WEIGHT (GMS)	2062	3086	3681	14443
U-238 (PCI/G)	1.01	1.08	.98	1.01
STDEV (PCT.)	3.2	1.5	3.5	1.6
TH-232 (PCI/G)	1.18	1.43	1.56	1.76
STDEV (PCT.)	3.9	1.7	3.4	1.5
K-40 (PCI/G)	16.8	21.1	25.9	25.8
STDEV (PCT.)	1.8	.8	1.5	.7
CS-137 (PCI/G)	.414	.279	.028	.019
STDEV (PCT.)	3.7	2.5	41.8	30.1

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02006	.00106
STDEV (PCT.)	4.4	16.3

SH11 BOULDER CITY, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1930	3102	3560	10713	
U-238 (PCI/G)	1.10	1.10	1.12	.87	
STDEV (PCT.)	3.1	3.1	3.0	1.7	
TH-232 (PCI/G)	1.04	1.12	1.25	1.38	
STDEV (PCT.)	4.3	4.2	3.8	1.7	
K-40 (PCI/G)	18.1	20.6	22.7	23.9	
STDEV (PCT.)	1.8	1.6	1.5	.7	
CS-137 (PCI/G)	.372	.328	.095	.015	
STDEV (PCT.)	4.1	4.4	12.2	36.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.02694	.00234
STDEV (PCT.)	3.8	9.3

SW02 LUND, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2476	3891	3301	12669	(694 SQ. CM.)
U-238 (PCI/G)	1.53	1.62	1.55	1.52	
STDEV (PCT.)	2.7	2.6	2.6	2.7	
TH-232 (PCI/G)	1.09	1.12	1.19	1.33	
STDEV (PCT.)	4.5	4.4	4.1	3.8	
K-40 (PCI/G)	16.9	18.2	17.9	19.1	
STDEV (PCT.)	2.0	1.9	1.9	1.9	
CS-137 (PCI/G)	.414	.398	.289	.086	
STDEV (PCT.)	3.9	4.2	5.2	14.3	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03237	.01156
STDEV (PCT.)	3.9	3.9

SW03 PRESTON, NEVADA

GAMMA ANALYSIS					
DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	2708	3466	3529	14896	(694 SQ. CM.)
U-238 (PCI/G)	1.50	1.53	1.59	1.60	
STDEV (PCT.)	2.6	2.6	2.6	2.5	
TH-232 (PCI/G)	1.53	1.57	1.55	1.64	
STDEV (PCT.)	3.4	3.4	3.5	3.3	
K-40 (PCI/G)	20.4	21.1	21.3	24.8	
STDEV (PCT.)	1.7	1.7	1.7	1.5	
CS-137 (PCI/G)	.603	.436	.226	.063	
STDEV (PCT.)	3.1	3.8	6.4	18.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.03379	.00729
STDEV (PCT.)	2.8	5.6

SW05 EUREKA, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1046	2792	3215	11401	(694 SQ. CM.)
U-238 (PCI/G)	1.03	1.25	1.46	1.43	
STDEV (PCT.)	3.7	1.7	1.3	1.1	
TH-232 (PCI/G)	.86	1.08	1.20	1.55	
STDEV (PCT.)	5.3	2.5	2.0	1.7	
K-40 (PCI/G)	11.1	14.9	17.9	21.0	
STDEV (PCT.)	2.6	1.2	.9	.8	
CS-137 (PCI/G)	3.080	.324	.076	.012	
STDEV (PCT.)	1.2	2.8	7.9	47.0	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.04608	.00121
STDEV (PCT.)	5.2	25.0

SW06 DUCKWATER, NEVADA

GAMMA ANALYSIS DEPTH INCREMENT	1	2	3	4	
DRY WEIGHT (GMS)	1206	1140	3605	17188	(694 SQ. CM.)
U-238 (PCI/G)	1.22	1.37	1.38	1.05	
STDEV (PCT.)	2.9	2.7	2.6	3.0	
TH-232 (PCI/G)	1.03	1.08	1.10	1.12	
STDEV (PCT.)	4.5	4.3	4.2	4.0	
K-40 (PCI/G)	17.0	17.3	17.2	18.3	
STDEV (PCT.)	1.9	1.8	1.8	1.7	
CS-137 (PCI/G)	1.224	1.307	.373	.011	
STDEV (PCT.)	1.9	1.8	4.0	87.8	

PLUTONIUM ANALYSIS	UPPER	LOWER
PU-239+240 (DPM/G)	.23566	.00716
STDEV (PCT.)	2.7	6.4