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Idaho National Engineering and Environmental Laboratory Offsite Environmental Surveillance Program Report: Second Quarter 2002

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EXECUTIVE SUMMARY

None of the radionuclides detected in any of the samples collected during the second quarter of 2002 could be directly linked with INEEL activities. Levels of detected radionuclides were no different than values measured at other locations across the United States or were consistent with levels measured historically at the INEEL. All detected radionuclide concentrations were well below guidelines set by the U.S. Department of Energy (DOE) and regulatory standards established by the U.S. Environmental Protection Agency (EPA) for protection of the public. (See Table ES-1.)

This report for the second quarter, 2002, contains results from the Environmental Surveillance, Education and Research (ESER) Program's monitoring of the Department of Energy's Idaho National Engineering and Environmental Laboratory's (INEEL) offsite environment, April 1 through May 30, 2002. All sample types (media) and the sampling schedule followed during 2002 are listed in Appendix A. Specifically, this report contains the results for the following:

- Air sampling, including air filters and charcoal cartridges, atmospheric moisture, and 10-micron particulate matter (PM_{10});
- Water sampling, including precipitation, surface water, and drinking water;
- Agricultural product sampling, including milk, sheep, and large game;
- Measurement of external exposure, using environmental dosimetry.

Results are presented in this report with an analytical uncertainty term, 2s, where "s" is an estimate of the population standard deviation (σ), assuming a Guassian distribution. The result plus or minus ($\pm$) the uncertainty term represents the 95 confidence interval. That is, there is 95 percent confidence that the real concentration in the sample lies somewhere between the measured concentration minus the uncertainty term and the measured concentration plus the uncertainty term. Results that are greater than the 2s uncertainty are considered "detected".

At no time during the second quarter were weekly, monthly, or quarterly gross alpha or gross beta concentrations in air for Boundary locations statistically higher than corresponding data for Distant locations, as one would expect if the INEEL were a significant source of radionuclide contamination. During the second quarter, analysis of charcoal cartridges in ten-cartridge batches for iodine-131 (^{131}I) did not detect any ^{131}I above the respective 2s values. Selected quarterly composite air filter samples were analyzed for gamma emitting radionuclides, strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}Pu$), and americium-241 (^{241}Am). Nine samples collected from air monitoring stations located at Arco, Arco QA, Atomic City, Blackfoot CMS, Blue Dome, Dubois, Main Gate, Mud Lake, and Jackson, Wyoming showed at least one human-made radionuclide greater than its related 2s value. These values are within the range of those measured in the past and are likely due to collection on the filter of resuspended fallout particles. All results were far less than their respective DOE Derived Concentration Guide (DCG) values.

Twenty-one atmospheric moisture samples were obtained during the second quarter of 2002. However, only eleven of the samples were determined by the analytical laboratory to produce valid results: five from Atomic City and six from Idaho Falls. All results exceeded their respective 2s values. The maximum value was well below the DCG for tritium in water.

The ESER Program operates three PM_{10} samplers, one each at Rexburg, Blackfoot, and Atomic City. Sampling of PM_{10} is informational as no analyses are conducted for contaminants. PM_{10} concentrations were well below all health standard levels for all samples. The maximum 24-hour concentration was 46.8 µg/m^3 on May 19, 2002, in Atomic City.

Little precipitation occurred during the second quarter of 2002. Only five samples, two monthly composite samples from the Central Facilities Area (CFA), one monthly composite sample from Idaho Falls and two weekly samples from the Experimental Field Station (EFS) on the INEEL. No tritium was detected above the respective 2s values in any of the samples.

Fourteen drinking water samples and one duplicate were collected from selected taps throughout southeast Idaho. Samples were analyzed for gross alpha, gross beta, and tritium (^{3}H). None of the samples exceeded the 2s value for gross alpha. Gross beta was measured at concentrations above the 2s value in eleven of the samples collected. The maximum gross beta concentration measured was from Minidoka and was below the EPA screening. Levels of gross alpha and gross beta observed are not unusual given the basaltic terrain.

Only the drinking water samples from Howe and Aberdeen were above the 2s level for tritium. The level of tritium detected in the samples from Howe and Aberdeen that were above 2s were much lower than the EPA limit. The measured levels were also within the range of background tritium that exists throughout the world. All values are similar to those recorded in previous years, and are well below the regulatory standards for drinking water.

Five surface water samples and one duplicate sample were collected from locations throughout southeast Idaho and analyzed for tritium, gross alpha, and gross beta. None of the results for either tritium or gross alpha analyses were above their 2s values. Results for gross beta for three of the five surface water samples were greater than their associated 2s values. The gross beta values were lower than the EPA screening level and below the DCG values and are consistent with historical measurements.

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL. All samples were analyzed for gamma emitting radionuclides. No ^{131}I or cesium-137 (^{137}Cs) was detected in any of the collected samples.

Individual sheep from three separate flocks were sampled including a control flock in Dubois from the Experimental Sheep Station, a flock from a southern INEEL allotment, and a flock from a northern INEEL allotment. Two sheep were taken from each flock. Thyroid, muscle, and liver tissue were collected and analyzed for gamma emitting radionuclides. No ^{131}I was found in any of the samples. Analysis for ^{137}Cs showed results greater than 2s in three samples from three different animals: one liver sample collected from an animal on the Northern allotment, and two muscle samples collected from each animal from the Southern allotment. All concentrations of ^{137}Cs were similar to those found in both onsite and offsite sheep samples during recent years.

No large game animals were sampled during the second quarter of 2002.

Environmental dosimeter locations are divided into Boundary and Distant groupings. Boundary exposure rates ranged from 0.30 to 0.38 mR/day. The overall average was 0.33 mR/day. The Distant set ranged from 0.30 to 0.41 mR/day. The average Distant value was

0.34 mR/day. No statistical difference existed between Boundary and Distant locations. All exposure results are consistent with those measured historically.

No radionuclides in any of the samples taken during the second quarter of 2002 could be directly linked with INEEL activities. Levels of detected radionuclides were no different than values measured at other locations across the United States and consistent with levels measured in the past in this area. Radionuclide concentrations in all of the samples collected and analyzed during the second quarter, 2002 were below guidelines set by both the DOE and the U.S. Environmental Protection Agency (EPA) for protection of the public.

Table ES-1 Summary of results for the second quarter of 2002.

Media	Sample Type	Analysis	Results
Air	Filters	Gross alpha, gross beta, ^{131}I	There were no statistical differences noted for weekly, monthly or quarterly gross alpha or gross beta concentrations measured at INEEL, Boundary, and Distant locations.
		Gamma emitting radionuclides, select actinides, ^{90}Sr	Quarterly composite samples had measurable levels of ^{241}Am and $^{239/240}Pu$ in samples from Arco, Arco QA, Atomic City, Blackfoot CMS, Blue Dome, Dubois, Main Gate, Mud Lake, and Jackson, WY. Results were well below DOE DCGs and historical measurements.
	Charcoal Cartridge	Iodine-131	No detections of ^{131}I were made during the quarter.
	PM10	Particulate matter	Thirty-eight total samples were collected from three locations. No regulatory limits were exceeded.
Atmospheric Moisture	Liquid	Tritium	Twenty-six atmospheric moisture samples were collected. Only eleven of the results were determined to be valid by the laboratory and were measurable tritium concentrations. No result exceeded the DCG for tritium in air.
Precipitation	Liquid	Tritium	No measurable concentrations of tritium were recorded during the quarter.
Drinking Water	Liquid	Gross alpha, gross beta, tritium	No gross alpha activity was detected in any sample. Gross beta activity was measured in of fifteen samples. The maximum concentration was well below the screening level estimated using the EPA Safe Drinking Water Act limit. Tritium was detected in two samples at concentrations many times lower than the EPA screening level.
Surface Water	Liquid	Gross alpha, gross beta, tritium	No tritium or gross alpha activity was detected in any sample. Gross beta activity was measured above the 2s values in three samples. All concentrations were below EPA and DOE limits.
Milk	Liquid	Iodine-131, gamma emitting radionuclides	Iodine-131 and ^{137}Cs were not detected in any sample during the quarter.
Sheep	Tissue	Iodine-131, gamma emitting radionuclides	Cs-137 was detected in three samples: two muscle samples from sheep collected off the Southern allotment and one liver from a Northern allotment animal. All results were within historical measurements.
Game Animals	Tissue	Iodine-131, gamma emitting radionuclides	No game animals were collected during this quarter.
Environmental Radiation	TLD	Ambient ionizing radiation	Values were consistent with expected exposures given the altitude and location of the TLD's. There were no statistical differences between Boundary and Distant location results.

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LIST OF ABBREVIATIONS

AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
CFA	Central Facilities Area
CMS	community monitoring station
DCG	Derived Concentration Guide
DOE	Department of Energy
DOE – ID	Department of Energy Idaho Operations Office
EAL	Environmental Assessment Laboratory
EFS	Experimental Field Station
EPA	Environmental Protection Agency
ERAMS	Environmental Radiation Ambient Monitoring System
ESER	Environmental Surveillance, Education, and Research
INEL	Idaho National Engineering Laboratory
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
ISU	Idaho State University
MDC	minimum detectable concentration
M&O	Management and Operating
NRTS	National Reactor Testing Station
PM	particulate matter
PM_{10}	particulate matter less than 10 micrometers in diameter
SI	Systeme International d'Unites
TLDs	thermoluminescent dosimeters
TRA	Test Reactor Area
UI	University of Idaho
WSU	Washington State University

LIST OF UNITS

Bq	becquerel
Ci	curie
g	gram
L	liter
µCi	microcurie
mL	milliliter
mR	milliroentgens
mrem	millirem (rem = unit of dose equivalent [roentgen-equivalent-man])
mSv	millisieverts
pCi	picocurie
R	Roentgen
µSv	microseiverts

1. ESER PROGRAM DESCRIPTION

Operations at the Idaho National Engineering and Environmental Laboratory (INEEL) are conducted under requirements imposed by the U.S. Department of Energy (DOE) under authority of the Atomic Energy Act, and the U.S. Environmental Protection Agency (EPA) under a number of acts (e.g. the Clean Air Act and Clean Water Act). The requirements imposed by DOE are specified in DOE Orders. These requirements include those to monitor the effects of DOE activities on and off of DOE facilities (DOE 1988). During calendar year 2002, environmental monitoring within the INEEL boundaries was primarily the responsibility of the INEEL Management and Operating (M&O) contractor, while monitoring outside the INEEL boundaries was conducted under the Environmental Surveillance, Education and Research (ESER) Program. The ESER Program is led by the S.M. Stoller Corporation in cooperation with its team members, including: the University of Idaho (UI) and Washington State University (WSU) for research, and MWH Global, Inc., and North Wind Environmental, Inc. for technical support. This report contains monitoring results from the ESER Program for samples collected during the second quarter of 2002 (April 1 – June 30, 2002).

The surveillance portion of the ESER Program is designed to satisfy the following program objectives:

- Verify compliance with applicable environmental laws, regulations, and DOE Orders;
- Characterize and define trends in the physical, chemical, and biological condition of environmental media on and around the INEEL;
- Assess the potential radiation dose to members of the public from INEEL effluents, and;
- Present program results clearly and concisely through the use of reports, presentations, newsletter articles, and press releases.

The goal of the surveillance program is to monitor different media at a number of potential exposure points within the various exposure pathways, including air, water, agricultural products, wildlife, and soil, that could possibly contribute to the radiation dose received by the public.

Environmental samples routinely collected include:

- air at 16 locations on and around the INEEL;
- moisture in air at four locations around the INEEL;
- surface water at five locations on the Snake River;
- drinking water at 14 locations around the INEEL;
- agricultural products, including milk at 10 dairies around the INEEL, potatoes from at least five local producers, wheat from approximately 10 local producers, lettuce from approximately nine home-owned gardens around the INEEL, and sheep from two operators which graze their sheep on the INEEL;
- soil from 13 locations around the INEEL biennially;
- environmental dosimeters from 15 locations semi-annually; and
- various numbers of wildlife including big game (pronghorn, mule deer, and elk), waterfowl, doves, and marmots sampled on and near the INEEL. Fish are also sampled as available (i.e., when there is flow in the Big Lost River).

Table A-1 in Appendix A lists samples, sampling locations and collection frequency for the ESER Program.

The ESER Program used two laboratories to perform analyses on routine environmental samples collected during the quarter reported here. The Idaho State University (ISU) Environmental Assessment Laboratory (EAL) performed routine gross alpha, gross beta, tritium, and gamma spectrometry analyses. Analyses requiring radiochemistry, including strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 (^{241}Am) were performed by Severn-Trent, Inc.

In the event of non-routine occurrences, such as suspected releases of radioactive material, the ESER Program may increase the frequency of sampling and/or the number of sampling locations based on the nature of the release and wind distribution patterns. Any data found to be outside historical norms in the ESER Program is thoroughly investigated to determine if an INEEL origin is likely. Investigation may include re-sampling and/or re-analysis of prior samples.

In the event of any suspected worldwide nuclear incidents, like the 1986 Chernobyl accident, the EPA may request additional sampling be performed through the Environmental Radiation Ambient Monitoring System (ERAMS) network (EPA 2002). The EPA established the ERAMS network in 1973 with an emphasis on identifying trends in the accumulation of long-lived radionuclides in the environment. ERAMS is comprised of a nationwide network of sampling stations that provide air, precipitation, surface water, drinking water, and milk samples. The ESER Program currently operates a high-volume air sampler and precipitation sampling equipment in Idaho Falls for this national program and routinely sends samples to EPA's Eastern Environmental Radiation Facility for analyses. The ERAMS data collected at Idaho Falls are not reported by the ESER Program but are available through the EPA ERAMS website (http://www.epa.gov/enviro/html/erams/).

Once samples have been collected and analyzed, the ESER Program has the responsibility for quality control of the data and for preparing quarterly reports on results from the environmental surveillance program. The quarterly reports are then consolidated into the INEEL Annual Site Environmental Report for each calendar year. Annual reports also include data collected by other INEEL contractors.

The results reported in the quarterly and annual reports are assessed in terms of data quality and statistical significance with respect to laboratory analytical uncertainties, sample locations, reported INEEL releases, meteorological data, and worldwide events that might conceivably have an effect on the INEEL environment. First, field collection and laboratory information are reviewed to determine identifiable errors that would invalidate or limit use of the data. Examples of these include insufficient sample volume, torn filters, evidence of laboratory cross-contamination or quality control issues. Data that pass initial screening are further evaluated using statistical methods. Statistical tools are necessary for data evaluation particularly since environmental measurements typically involve the determination of minute concentrations, which are difficult to detect and even more difficult to distinguish from other measurements.

The term "measurable" as used for the discussion of results in this report does not imply any degree of risk to the public or environment but rather indicates that the radionuclide was detected at a concentration sufficient for the analytical instrument to record a value. The minimum detectable concentration (MDC) is used to assess measurement process capabilities. The MDC indicates the ability of the laboratory to detect an analyte in a sample at desired concentration levels. The ESER requires that the laboratory be able to detect radionuclides at levels below that normally expected in environmental samples, as observed historically in the

region. These levels are typically well below regulatory limits. The MDC is instrument and analysis specific, and is established by the analytical laboratory at the beginning of each analytical run.

It is the goal of the ESER program to minimize the error of saying something is not present when it actually is, to the extent that is reasonable and practicable. This is accomplished through the use of the uncertainty term, which is reported by the analytical laboratory with the sample result. Results are presented in this report with an analytical uncertainty term, 2s, where "s" is an estimate of the population standard deviation (σ), assuming a Guassian or normal distribution. The result plus or minus ($\pm$) the uncertainty term (2s) represents the 95 confidence interval for the measurement. That is, there is 95 percent confidence that the real concentration in the sample lies somewhere between the measured concentration minus the uncertainty term and the measured concentration plus the uncertainty term. By using a 2s value as a reporting level, the error rate for saying something is not there when it is, is kept to less than 5%. However, there may be a relatively high error rate for false detections (reporting something as present when it actually is not) for results near their 2s uncertainty levels. This is because the variability around the sample result may substantially overlap the variability around a net activity of zero for samples with no radioactivity. Analyses with results in the questionable range (2s to 3s) are thus presented in this report with the understanding that the radionuclide may not actually be present in the sample. If a result exceeds three times its estimated uncertainty (3s), there is confidence that the radionuclide is present in the sample. If a result is less than or equal to 2s there is little confidence that the radionuclide is present in the sample. A more detailed discussion about confidence in detections may be found in Confidence in Detections under Helpful Information.

For more information concerning the ESER Program, contact the S.M. Stoller Corporation at (208) 525-9358, or visit the Program's web page (http://www.stoller-eser.com).

2. THE INEEL

The INEEL is a nuclear energy research and environmental management facility. It is owned and administered by the U.S. Department of Energy, Idaho Operations Office (DOE-ID) and occupies about 890 mi^2 (2,300 km^2) of the upper Snake River Plain in Southeastern Idaho. The history of the INEEL began during World War II when the U.S. Naval Ordnance Station was located in Pocatello, Idaho. This station, one of two such installations in the U.S., retooled large guns from U.S. Navy warships. The retooled guns were tested on the nearby-uninhabited plain, known as the Naval Proving Ground. In the years following the war, as the nation worked to develop nuclear power, the Atomic Energy Commission (AEC), predecessor to the DOE, became interested in the Naval Proving Ground and made plans for a facility to build, test, and perfect nuclear power reactors.

The Naval Proving Ground became the National Reactor Testing Station (NRTS) in 1949, under the AEC. By the end of 1951, a reactor at the NRTS became the second to produce useful amounts of electricity. Over time the site has evolved into an assembly of 52 reactors, associated research centers, and waste handling areas. The NRTS was renamed the Idaho National Engineering Laboratory (INEL) in 1974 and the INEEL in January 1997. With renewed interest in nuclear power the DOE announced in 2002 that Argonne National Laboratory and the INEEL are to be the lead laboratories for development of the next generation of power reactors. Other activities at the INEEL include environmental cleanup, subsurface research, and technology development.

3. AIR SAMPLING

The primary pathway by which radionuclides can move off the INEEL is through the air and for this reason the air pathway is the primary focus of monitoring on and around the INEEL. Samples for particulates and iodine-131 (^{131}I) gas in air were collected weekly at 16 locations using low-volume air samplers for the duration of the quarter. Moisture in the atmosphere was sampled at four locations around the INEEL and analyzed for tritium. Concentrations of airborne particulates less than 10 micrometers in diameter (PM_{10}) were measured for comparison with EPA standards at three locations. Air sampling activities and results for the second quarter, 2002 are discussed below. A summary of approximate minimum detectable concentrations (MDCs) for radiological analyses and DOE Derived Concentration Guide (DCG) (DOE 1993) values is provided in Appendix B.

LOW-VOLUME AIR SAMPLING

Radioactivity associated with airborne particulates was monitored continuously by 18 low-volume air samplers (two of which are used as replicate samplers) at 16 locations during the second quarter of 2002 (Figure 1). Three of these samplers are located on the INEEL, nine are situated off the INEEL near the boundary, and six have been placed at locations distant to the INEEL. Samplers are divided into INEEL, Boundary, and Distant groups to determine if there is a gradient of radionuclide concentrations, increasing towards the INEEL. Each replicate sampler is relocated every year to a new location. One replicate sampler was placed at Arco (Boundary location) and one at Howe (Boundary location) during 2002. An average of 13,168 ft^3 (373 m^3) of air was sampled at each location, each week, at an average flow rate of 1.3 ft^3/min (0.04 m^3/min). Particulates in air were collected on glass fiber particulate filters (1.2-µm pore size). Gases passing through the filter were collected with an activated charcoal cartridge.

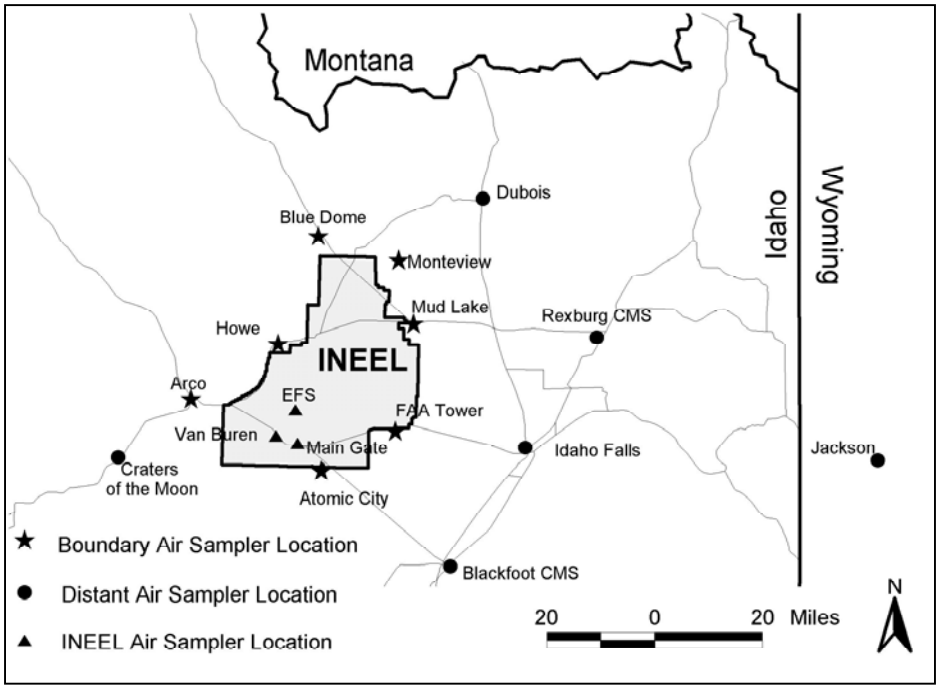

Figure 1. Low-volume air sampler locations.

Filters and charcoal cartridges were changed weekly at each station during the quarter. Each particulate filter was analyzed for gross alpha and gross beta radioactivity using thin-window gas flow proportional counting systems after waiting about four days for naturally-

occurring daughter products of radon and thorium to decay. More information concerning gross alpha and beta radioactivity can be found in Gross versus Specific Analyses under Helpful Information.

The weekly particulate filters collected during the quarter for each location were composited and analyzed for gamma-emitting radionuclides. Composites were also analyzed by location for ^{90}Sr, or ^{238}Pu, $^{239/240}Pu$, and ^{241}Am as determined by a rotating quarterly schedule.

Charcoal cartridges were analyzed for gamma-emitting radionuclides, specifically for iodine-131 (^{131}I). Iodine-131 is of particular interest because it is produced in relatively large quantities by nuclear fission, is readily accumulated in human and animal thyroids, and has a half-life of eight days. This means that any elevated level of 131I in the environment could be from a recent release of fission products.

Gross alpha results are reported in Table C-1. Median gross alpha concentrations in air for INEEL, Boundary, and Distant locations for the second quarter of 2002 are shown in Figure 2. The data were tested for normality prior to statistical analyses. For the most part the data showed no discernable distribution. Box and whisker plots are commonly used when there is no assumed distribution. Each data group in Figure 2 is presented as a box and whisker plot, with a median, a box enclosing values between the 25th and 75th percentiles, and whiskers representing the non-outlier range. Note that outliers and extreme values are identified separately from the box and whiskers. Outliers and extreme values are atypical, infrequent, data points that are far from the middle of the data distribution. For this report, outliers are defined as values that are greater than 1.5 times the height of the box, above or below the box. Extreme values are greater than 2 times the height of the box, above or below the box. Outliers and extreme values may reflect inherent variability, may be due to errors associated with transcription or measurement, or may be related to other anomalies. A careful review of the data collected during the second quarter indicates that the outliers and extreme values were not due to mistakes in collection, analysis, or reporting procedures, but rather reflect natural variability in the measurements. The outliers and extreme values lie within the range of measurements made within the past five years. Thus, rather than dismissing the outliers, they were included in the subsequent statistical analyses. Further discussion of box plots may be found in Determining Statistical Differences under Helpful Information.

Figure 2 graphically shows that the gross alpha measurements made at INEEL, Boundary, and Distant locations are similar for the second quarter. If the INEEL were a significant source of offsite contamination, concentrations of contaminants could be statistically greater at Boundary locations than at Distant locations. Because there is no discernable distribution of the data, the nonparametric Kruskal-Wallis test of multiple independent groups was used to test for statistical differences between INEEL, Boundary, and Distant locations. The use of nonparametric tests, such as Kruskal-Wallis, gives less weight to outliers and extreme values thus allowing a more appropriate comparison of data groups. A statistically significant difference exists between data groups if the (p) value is less than 0.05. Values greater than 0.05 translate into a 95 percent confidence that the medians are statistically the same. The p-value for each comparison is shown in Table D-1. There were no statistical differences in gross alpha concentrations between groups of data during the second quarter 2002.

Comparisons of gross alpha concentrations were made for each month of the quarter (Figures 3 – 5). Again the Kruskal-Wallis test of multiple independent groups was used to determine if statistical differences exist between INEEL, Boundary, and Distant data groups. There were no statistical differences in gross alpha results between groups for any month during the second quarter (Table D-1).

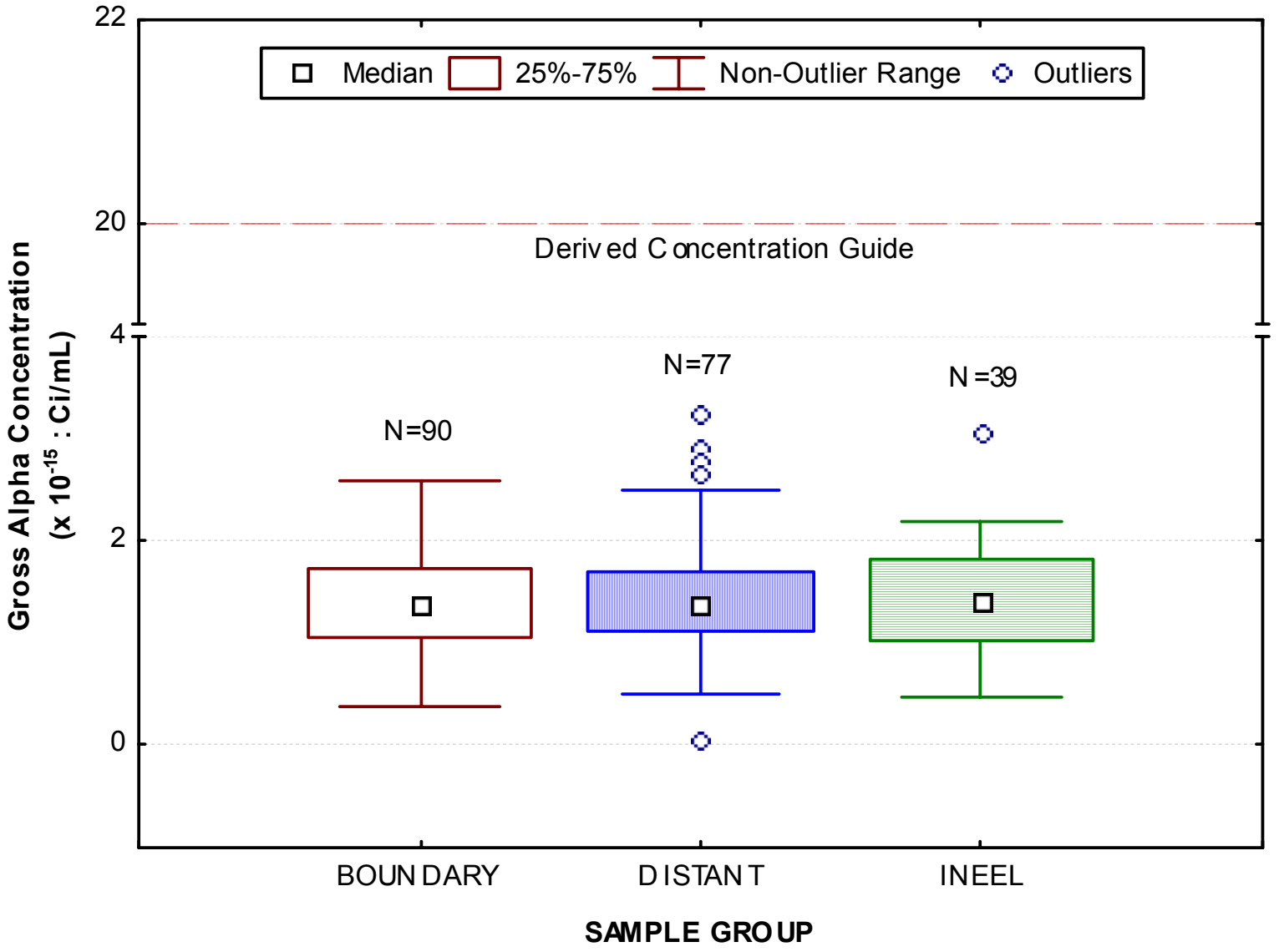

Figure 2. Gross alpha concentrations in air at ESER Program INEEL, Boundary, and Distant locations for the second quarter of 2002.

As a further check, comparisons between gross alpha concentrations measured at Boundary and Distant locations were made on a weekly basis. The Mann-Whitney U test was used to compare the Boundary and Distant data because it is the most powerful nonparametric alternative to the t-test for independent samples. INEEL sample results were not included in this analysis because the onsite data, collected at only three locations, are not representative of the entire INEEL and would not aid in determining offsite impacts. The gross alpha concentrations measured at Boundary locations were not statistically greater than those measured at Distant locations in any of the thirteen weeks of data evaluated (Table D-2). More detail on the statistical tests used can be found in Determining Statistical Differences under Helpful Information.

Gross beta results are presented in Table C-1. Gross beta concentrations in air for INEEL, Boundary, and Distant locations for the second quarter of 2002 are shown in Figure 6. The data were tested and found to be neither normally nor lognormally distributed. Box and whiskers plots were used for presentation of the data. Outliers and extreme values were retained in subsequent statistical analyses because they are within the range of measurements made in the past five years, and because these values could not be attributed to mistakes in collection, analysis, or reporting procedures. As in the case of alpha activity, the quarterly data for each group appear to be similar and were determined using the Kruskal-Wallace test to be statistically the same (Table D-1).

Monthly median gross beta concentrations in air for each sampling group are shown in Figures 7 – 9. Statistical data are presented in Table D-1. As in the case of alpha activity, the monthly data for each group during the second quarter 2002 appear to be similar and were determined using the Kruskal-Wallace test to be statistically the same (Table D-1).

Comparison of weekly Boundary and Distant data sets, using the Mann Whitney U test, indicate no statistical differences between weekly Boundary and Distant measurements during the second quarter 2002 (Table D-2).

No ^{131}I was detected in any of the charcoal cartridge batches collected during the second quarter of 2002. Weekly ^{131}I results for each location are listed in Table C-2 of Appendix C Gamma spectrographic analysis is also done with the ^{131}I analysis. Cesium-137 was not detected in any of the measured cartridges.

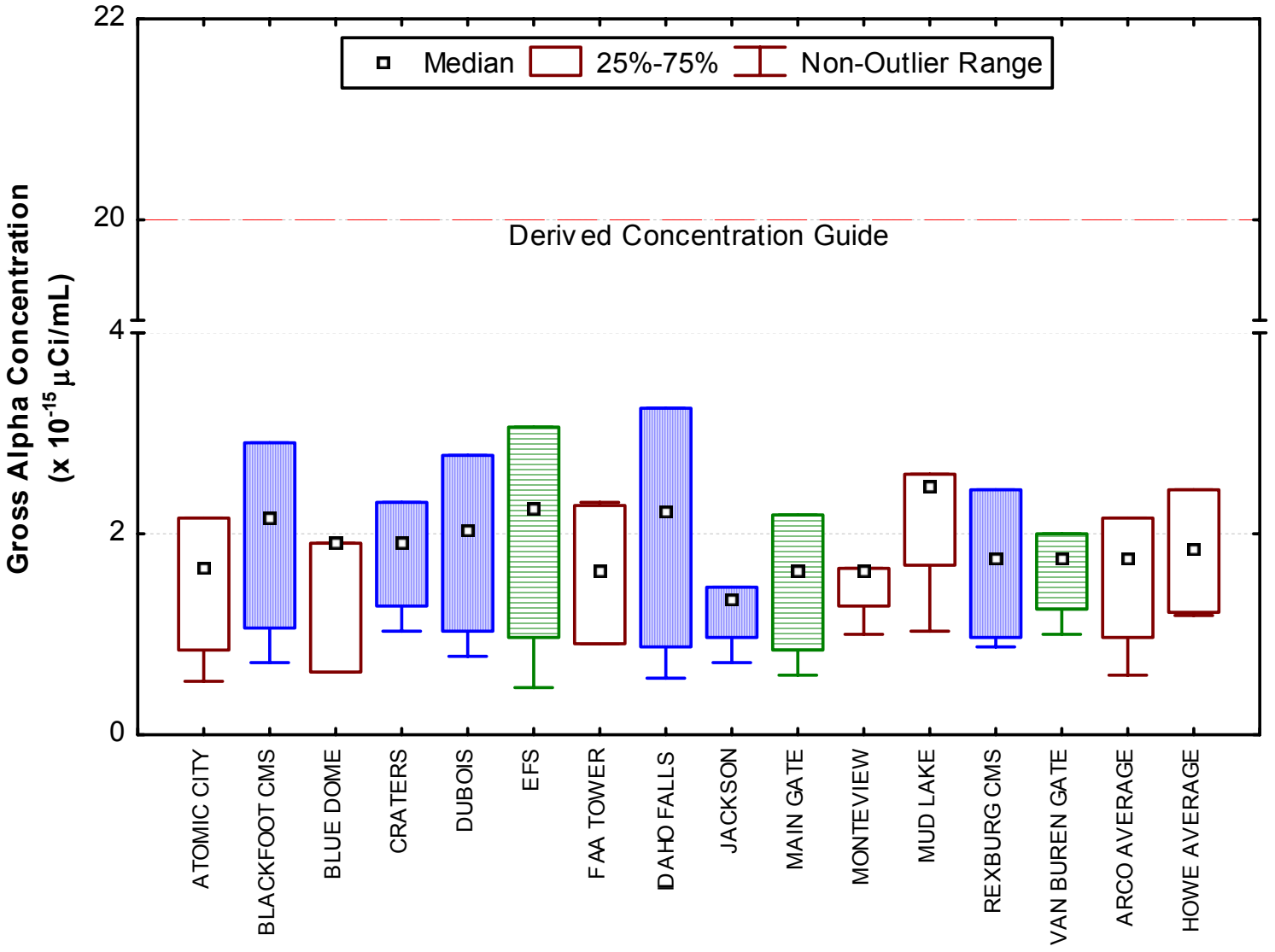

Figure 3. April gross alpha concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 4 at each location except for Blue Dome, where N=3.]

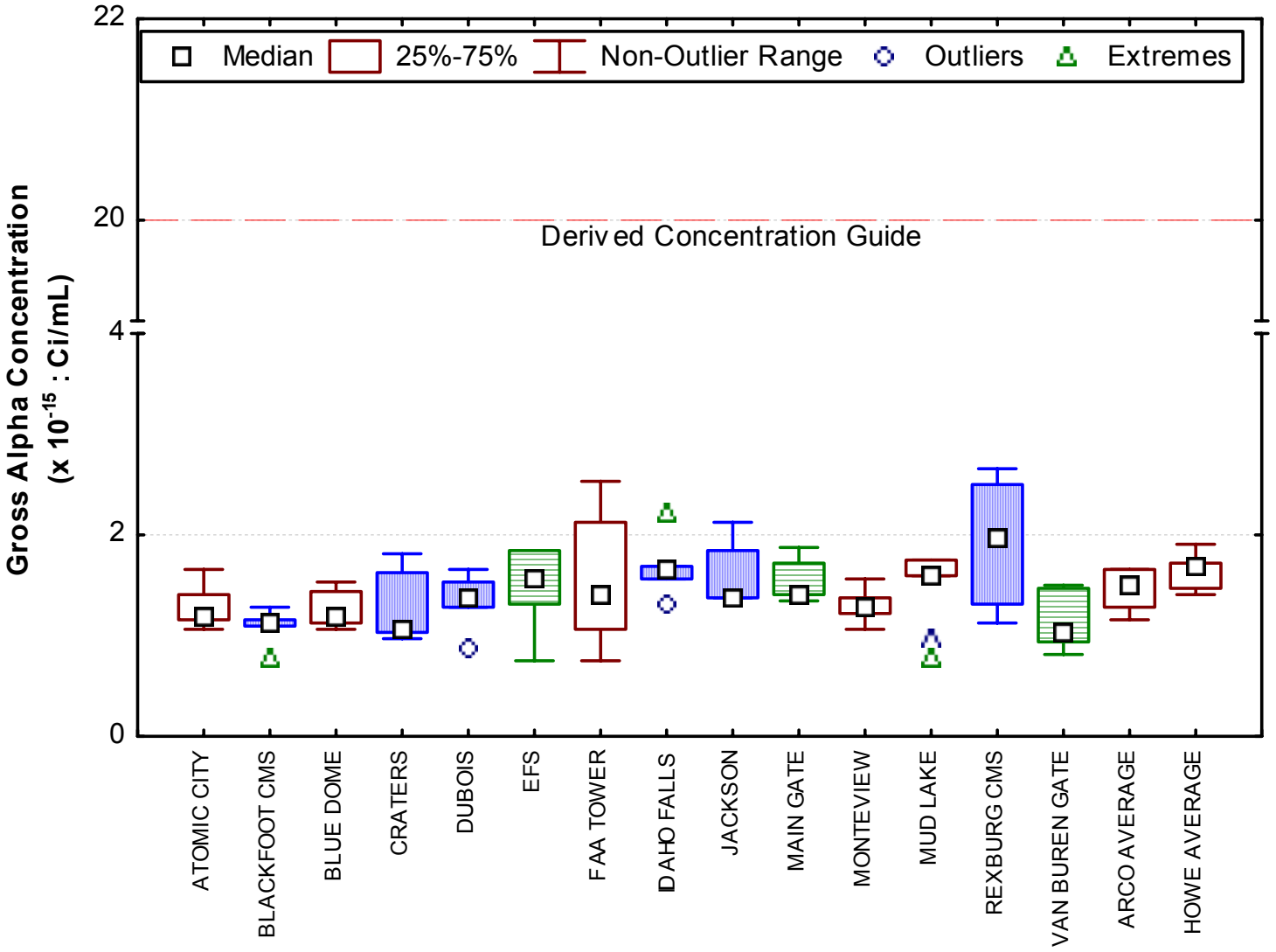

Figure 4. May gross alpha concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 5 at each location.]

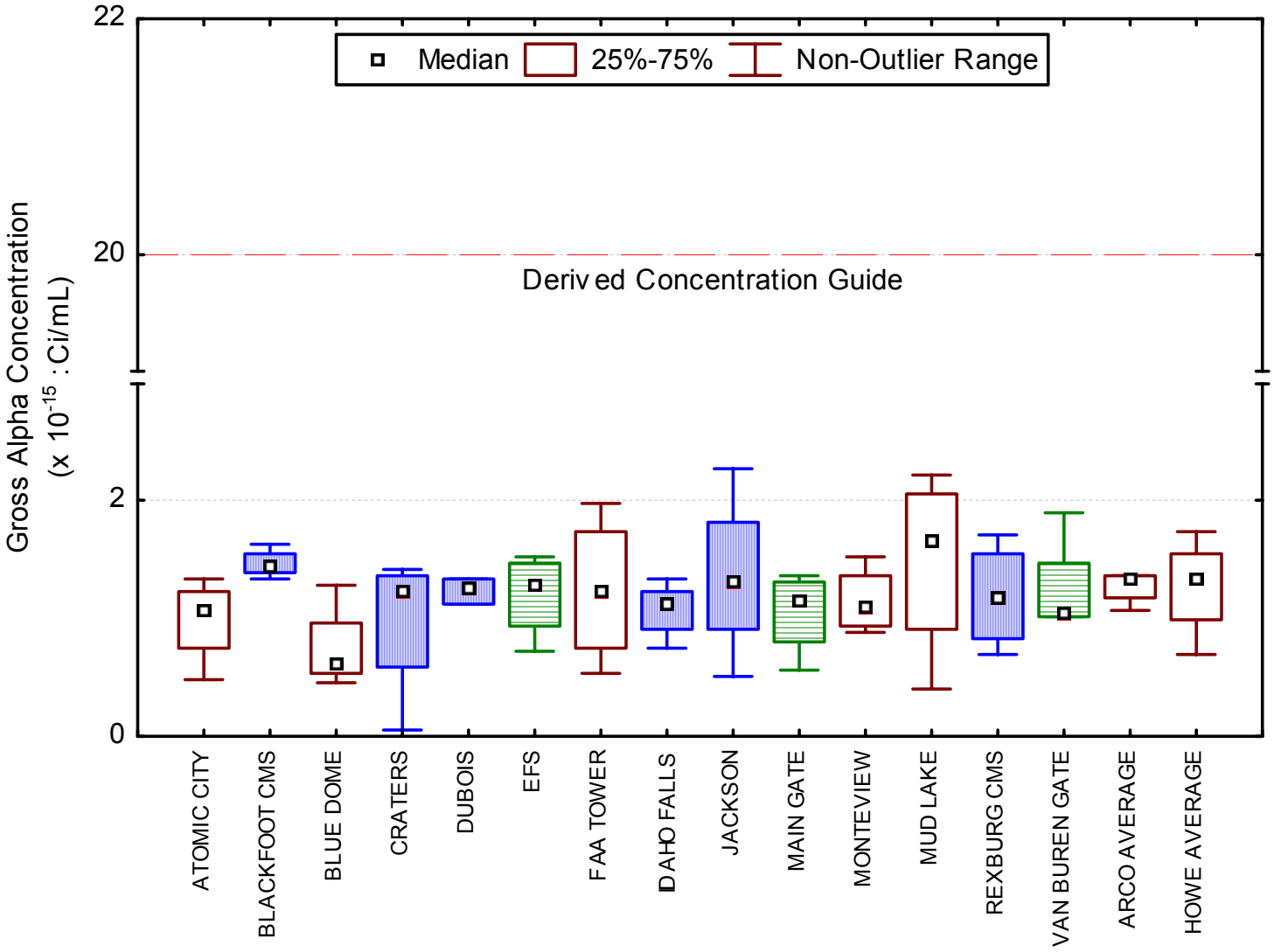

Figure 5. June gross alpha concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 4 at each location, except for Dubois, where N=3.]

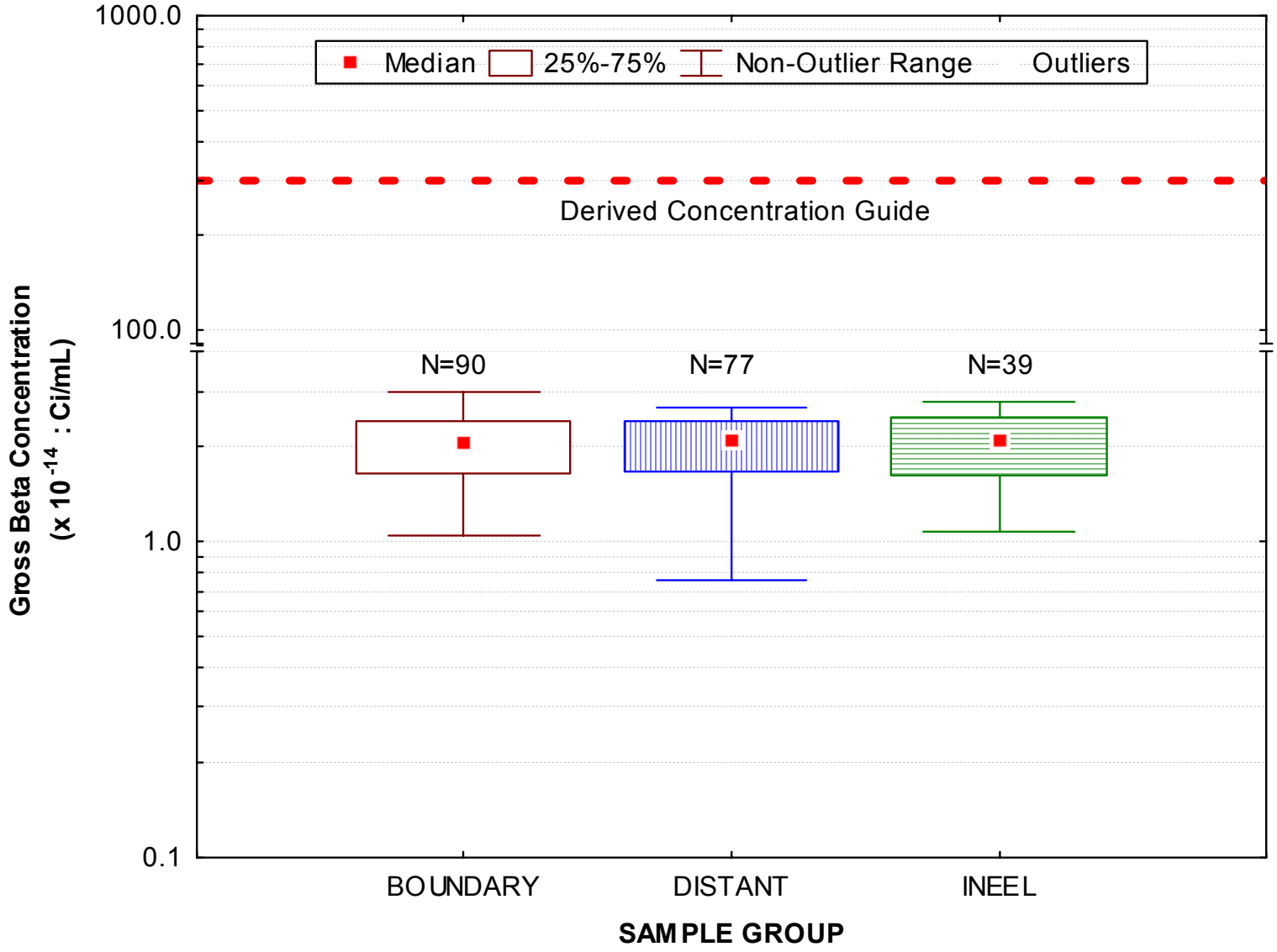

Figure 6. **Gross beta concentrations in air at ESER Program INEEL, Boundary, and Distant locations for the second quarter 2002.**

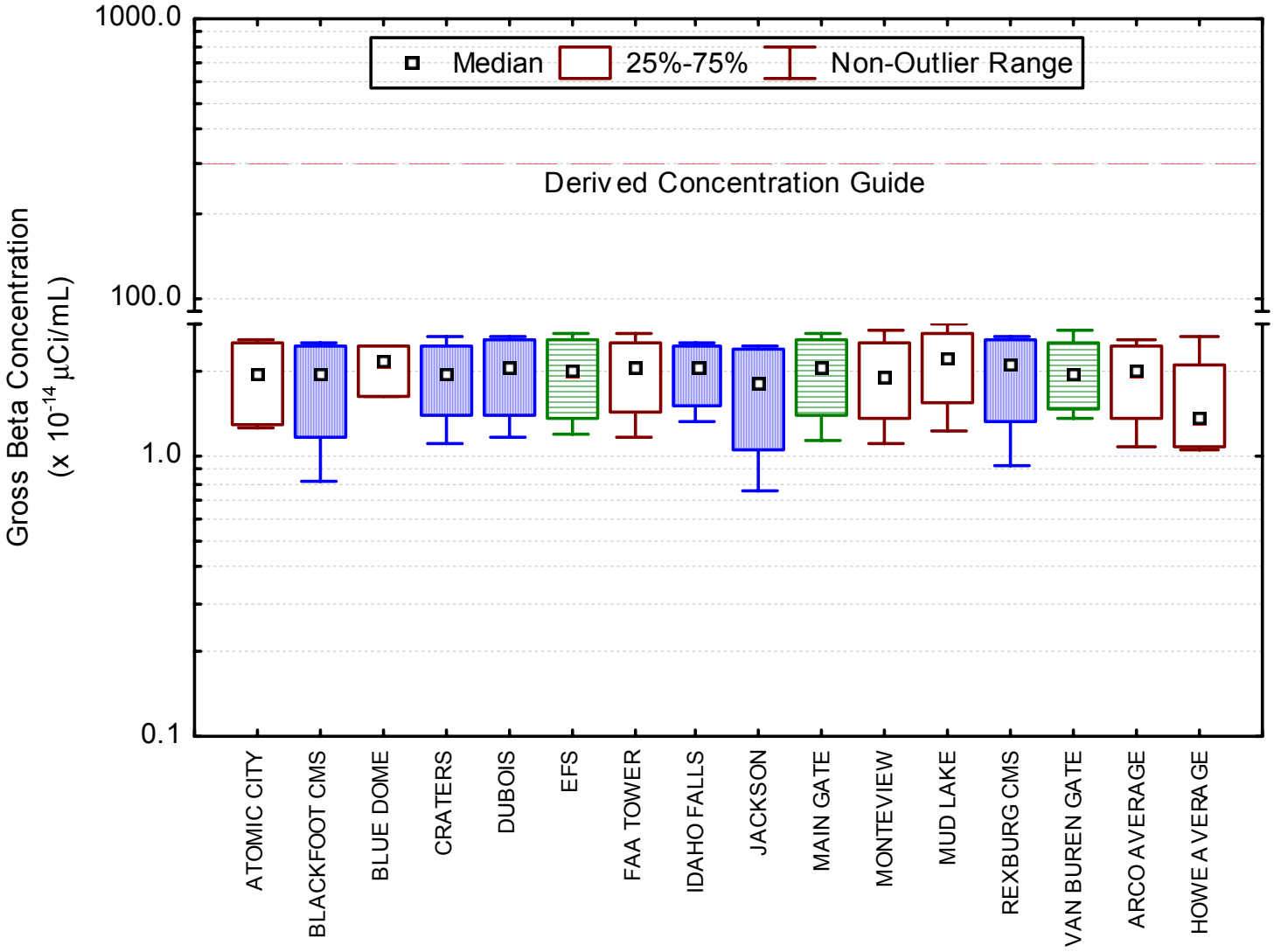

Figure 7. April gross beta concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 4 at each location except for Blue Dome, where N=3.]

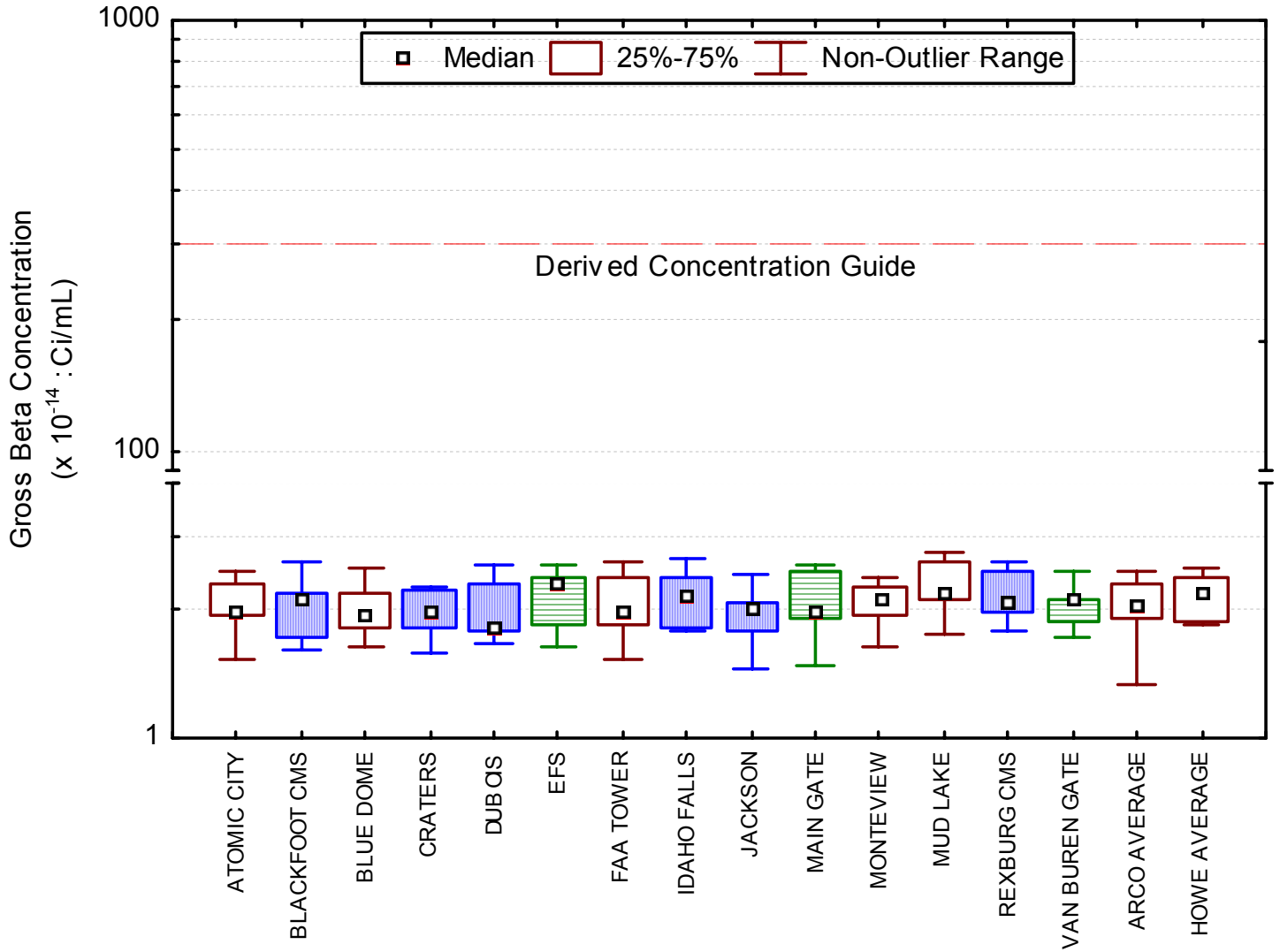

Figure 8. May gross beta concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 5 at each location.]

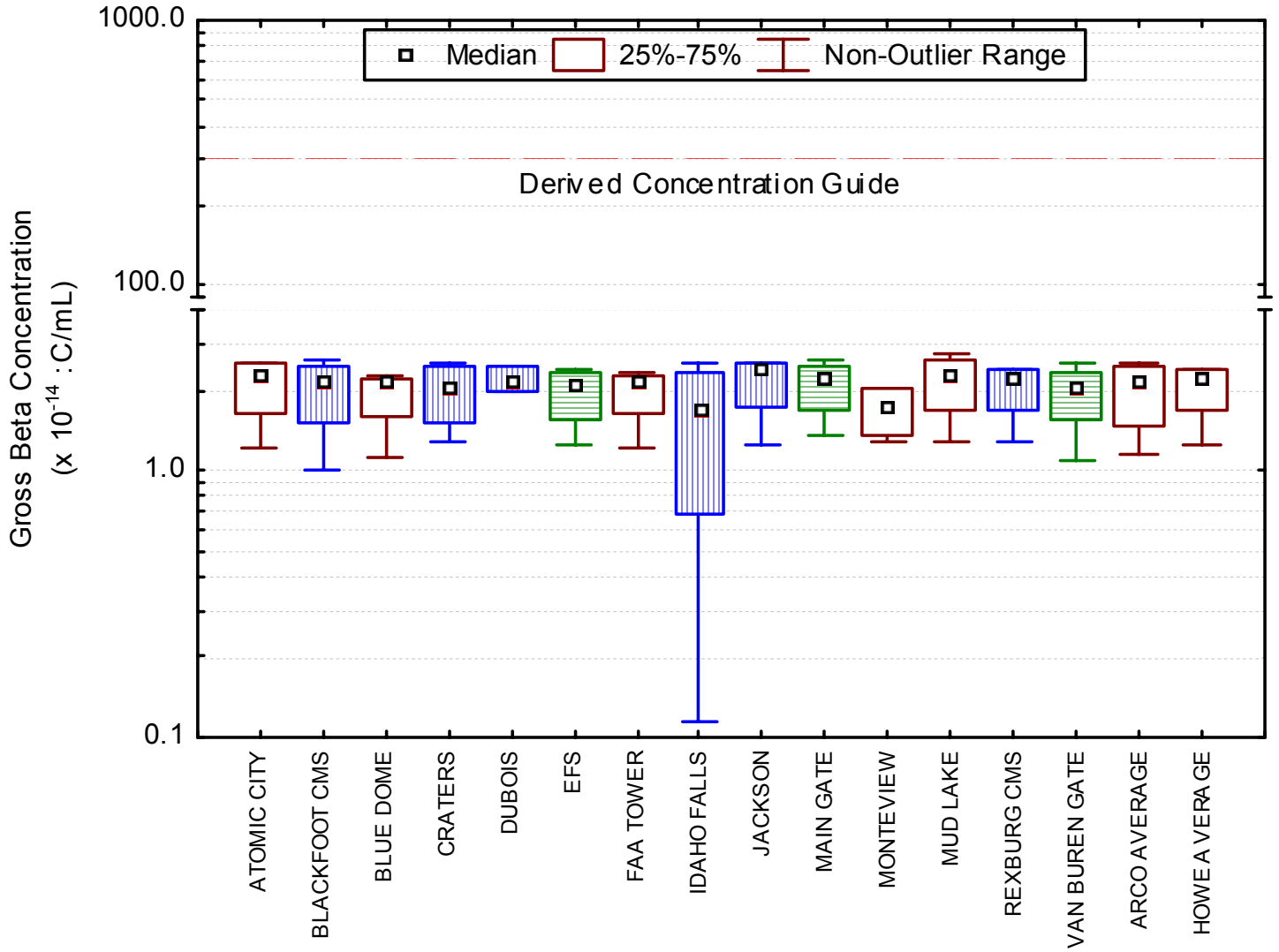

Figure 9. June gross beta concentrations in air at ESER Program INEEL, Boundary, and Distant locations. Stations belonging to INEEL, Boundary, or Distant locations are represented by boxes that are patterned with vertical green stripes, no fill, or horizontal blue stripes, respectively. [Number of samples (N) = 4 at each location, except for Dubois, where N=3.]

Weekly filters for the second quarter of 2002 were composited by location. All samples were analyzed for gamma-emitting radionuclides, including ^{137}Cs. Composites were also analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. Nine samples (composited quarterly from the individual air filters collected weekly at Arco, Arco QA, Atomic City, Blackfoot CMS, Blue Dome, Dubois, Main Gate, Mud Lake, and Jackson, WY) showed at least one human-made radionuclide greater than its related 2s value (Figure 10). Occasional detection of human-made radionuclides is not unusual and represents natural variations of these fallout introduced radionuclides. The concentrations measured during this quarter are consistent with those recorded in the past. All results were far less than their respective DCGs. All results for composite filter samples are shown in Table C-3, Appendix C.

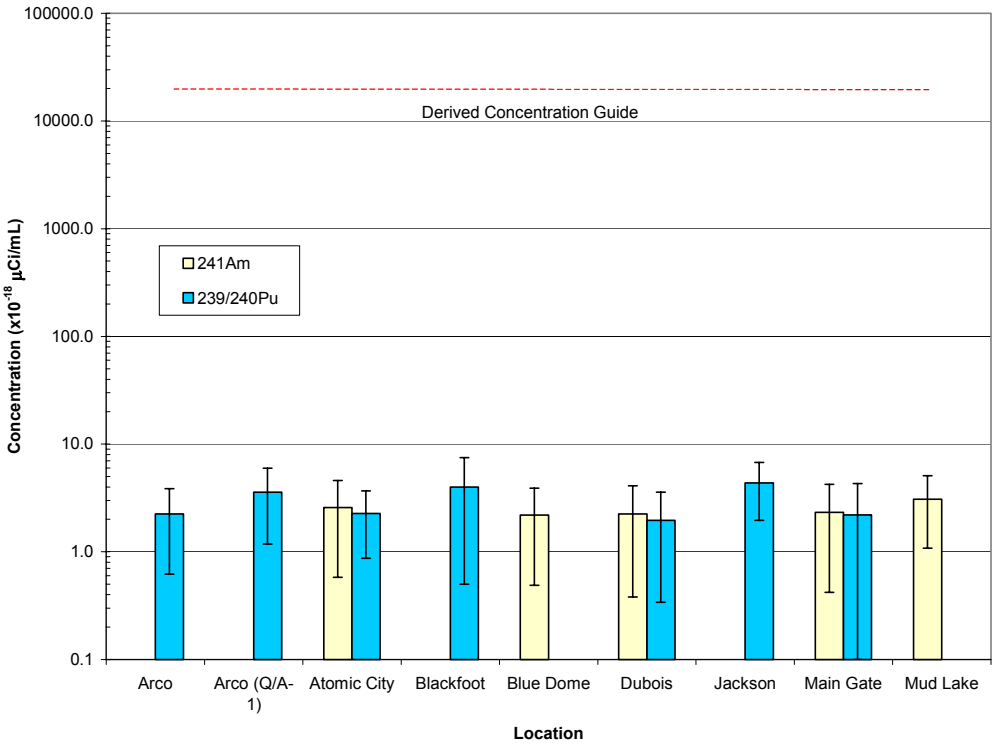

Figure 10. Specific radionuclides detected in quarterly composite air filters (by locations). Each column represents a result. Error bars above and below the result represent the ± 2s analytical uncertainty associated with each result.

ATMOSPHERIC MOISTURE SAMPLING

Atmospheric moisture is collected by pulling air through a column of absorbent material (i.e., silica gel) to absorb water vapor. The water is then extracted from the absorbent material by heat distillation. The resulting water samples are then analyzed for tritium using liquid scintillation. Starting in 2002 the ESER program began an evaluation of Drierite (anhydrous calcium sulfate) as an absorbent material. Twenty-six atmospheric moisture samples were obtained during the second quarter of 2002 from Atomic City, Blackfoot CMS, Idaho Falls, and Rexburg CMS. However, seventeen of the samples, all collected using drierite, yielded invalid results at the ISU analytical laboratory. It was determined by ISU that the drierite contains a contaminant, yet unidentified, that is released during the extraction process and produces

increasing counts during liquid scintillation analysis (Claver and Arndt 2003). For this reason, drierite will no longer be used as a collection medium.

Eleven valid results were reported for the second quarter: five from Atomic City and six from Idaho Falls. Each result, shown in Table C-4, was greater than its 2s uncertainty. The results were all well below the DOE DCG for tritium in air of 1×10^{-7} µCi/mL (3.7×10^{-3} Bq/mL). The maximum value was 9.3×10^{-12} µCi/mL of air (3.4×10^{-7} Bq/mL of air), collected at Idaho Falls on 5/31/02.

PM_{10} Air Sampling

The EPA began using a standard for concentrations of airborne particulate matter (PM) less than 10 micrometers in diameter (PM_{10}) in 1987 (40 CFR 50.6). Particles of this size can be inhaled deep into the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for these particulates are an annual average of 50 µg/m^3, with a maximum 24-hour concentration of 150 µg/m^3.

The ESER Program operates three PM_{10} samplers, one each at the Rexburg CMS and Blackfoot CMS, and one in Atomic City. Sampling of PM_{10} is informational only as no chemical analyses are conducted for contaminants. A twenty-four hour sampling period is scheduled to run once every six days. Equipment and measurement problems nullified a number of samples from each location (four each from Atomic City and the Rexburg CMS, and one from the Blackfoot CMS). The maximum 24-hour concentration was 46.76 µg/m^3 on May 19, 2002, at Atomic City. The average, maximum, and minimum results of the 24-hour samples are shown are shown in Table 1. Results for all PM_{10} samples are listed in Table C-5, Appendix C.

Table 1 Summary of 24-hour PM_{10} values (:g/m^3).

	Concentration[a]		
Location	**Minimum**	**Maximum**	**Average**
Atomic City	3.63	46.76	16.99
Blackfoot, CMS	7.68	30.20	19.1
Rexburg, CMS	1.76	37.79	16.10

a. All concentrations are in (:Ci/m^3).

4. WATER SAMPLING

The ESER program samples precipitation, surface water, and drinking water. Monthly composite precipitation samples are collected from Idaho Falls and the Central Facilities Area (CFA) on the INEEL. Weekly precipitation samples are collected from the Experimental Field Station (EFS) on the INEEL. Surface and/or drinking water are sampled twice each year at 19 locations around the INEEL. This occurs during the second and fourth quarters. The results of the second quarter sampling are reported here.

PRECIPITATION SAMPLING

Precipitation samples are gathered when sufficient precipitation occurs to allow for the collection of the minimum sample volume of approximately 20 mL. Samples are taken of a monthly composite from Idaho Falls and CFA, and weekly from the EFS. Precipitation samples are analyzed for tritium. Storm events in the second quarter of 2002 produced only minimal precipitation yielding a total of 5 samples – two from the EFS and CFA, and one from Idaho Falls.

No tritium was measured above the sample's 2s value in any of the samples collected during the second quarter 2002. Data for all second quarter 2002 precipitation samples collected by the ESER Program are listed in Table C-6 (Appendix C).

DRINKING WATER

Fourteen drinking water samples and one duplicate were collected from selected taps throughout southeast Idaho (Figure 11). Samples were analyzed for gross alpha, gross beta, and tritium (^{3}H). None of the water samples exceeded their respective 2s value for gross alpha.

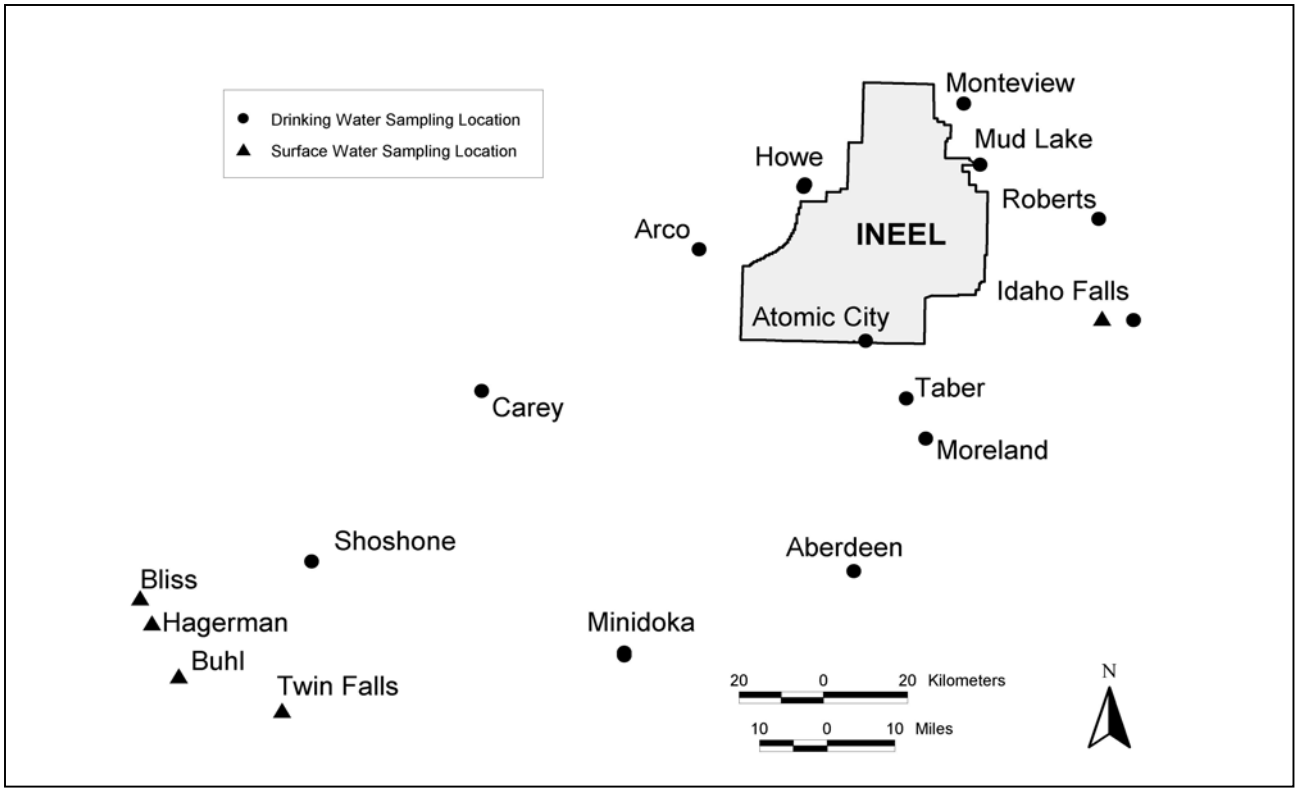

Figure 11. Drinking and Surface Water Sampling locations.

Of the fifteen water samples collected all but four (Arco, Atomic City, Carey, and Howe) exceeded their 2s value for gross beta (Table 2). The EPA Safe Drinking Water Act (SDWA) limits gross beta in drinking water based on an annual exposure of 4 mrem/yr. Since data are reported from the laboratory as a concentration (i.e., pCi/L) a screening concentration of 50 pCi/L is used to meet this level (Appendix B-1). The maximum concentration of gross beta detected was from Minidoka and was lower than the SDWA screening value. Levels of gross beta observed in drinking water are not unusual given the basaltic terrain (USGS 1991). All values are similar to those recorded in previous years, and are well below the levels outlined for drinking water protection (Table B-1). All drinking water sample results may be found in Appendix C, Table C-7.

Table 2. Drinking water tritium and gross beta results greater than (>) 2s.

	Sample Results[a]		Limits for Comparison[a]	
Location	**Result ± 2s**	**MDC**	**SDWA**	**DOE DCG**
		Tritium		
Aberdeen	349.90 ± 71.54	128.46	20,000	2×10^6
Howe	316.54 ± 71.08	128.46	20,000	2×10^6
		Gross Beta		
Aberdeen	2.80 ± 2.05	3.24	15	100
Duplicate	4.54 ± 2.02	3.01	15	100
Fort Hall	3.67 ± 2.09	3.25	15	100
Idaho Falls	3.58 ± 1.82	2.73	15	100
Minidoka	2.20 ± 1.92	3.09	15	100
Monteview	8.74± 2.52	3.50	15	100
Moreland	7.25 ± 2.46	3.49	15	100
Mud Lake	3.38 ± 1.61	2.41	15	100
Roberts	4.28 ± 1.82	2.69	15	100
Shoshone	1.98 ± 1.89	3.04	15	100
Tabor	4.71 ± 1.93	2.83	15	100

a. All values shown are in picocuries per liter (pCi/L).

Only the Howe and Aberdeen samples exceeded their 2s values for tritium. The SDWA limits tritium in drinking water to 2×10^4 pCi/L (Appendix B-1). The concentration of tritium detected in these samples was many times lower than the SDWA limit. The measured levels were also within the range of natural tritium that exists in the Snake River Plain Aquifer and throughout the world. Low levels of tritium exist in the environment at all times. The major natural source of tritium is cosmic ray reactions in the upper atmosphere. From 1978 to 2001 the EPA, as part of its ERAMS, measured tritium from -9.00×10^1 to 1.00×10^3 pCi/L in drinking water samples across the United States (EPA, 2002).

SURFACE WATER

Five surface water samples and one duplicate sample were collected from locations throughout southeast Idaho and analyzed for tritium, gross alpha, and gross beta. None of the samples were greater than their respective 2s values for either tritium or gross alpha activity.

Three of the five surface water samples were greater than their associated 2s values for gross beta (Table 3). Even at reported levels, the gross beta values are lower than the SDWA screening value of 15 pCi/L and the DCG values (Table B-1).

Table 3. Surface water gross beta results greater than (>) 2s.

		Limits for Comparison[a]	
Location	**Result ± 2s**	**SDWA**	**DOE DCG**
Bliss (Bliss Boat Dock)	3.40 ± 1.90	15	100
Buhl (Clear Spring)	3.48 ± 1.90	15	100
Twin Falls (Alpheus Spring)	7.05 ± 2.15	15	100

The presence of gross alpha and gross beta in surface water (particularly the springs) is typically related to dissolution of naturally occurring radionuclides (i.e., uranium, radium, potassium) by groundwater as it flows through the surrounding basalts (USGS, 1991). Levels of gross alpha and gross beta in all samples are similar to results from recent years. All gross alpha and gross beta results can be found in Appendix C, Table C-7.

5. AGRICULTURAL PRODUCTS AND WILDLIFE SAMPLING

Another potential pathway for contaminants to reach humans is through the food chain. The ESER Program samples multiple agricultural products and game animals from around the INEEL and Southeast Idaho. Specifically, milk, wheat, potatoes, garden lettuce, sheep, big game, waterfowl, and marmots are sampled. Milk is sampled throughout the year. Sheep are sampled during the second quarter. Lettuce and wheat are sampled during the third quarter, while potatoes and waterfowl are collected during the fourth quarter. See Table A-1, Appendix A, for more details on agricultural product and wildlife sampling. This section discusses results from milk, and large game sampled during the second quarter of 2002.

MILK SAMPLING

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL (Figure 12) during the second quarter of 2002. All samples were analyzed for gamma emitting radionuclides. Samples are analyzed for ^{90}Sr during the second and fourth quarters.

Iodine-131 (^{131}I), ^{137}Cs, and ^{90}Sr were not detected in any milk sample during the quarter. Data for ^{131}I, ^{137}Cs, and ^{90}Sr in milk samples are listed in Appendix C, Table C-8 and Table C-9.

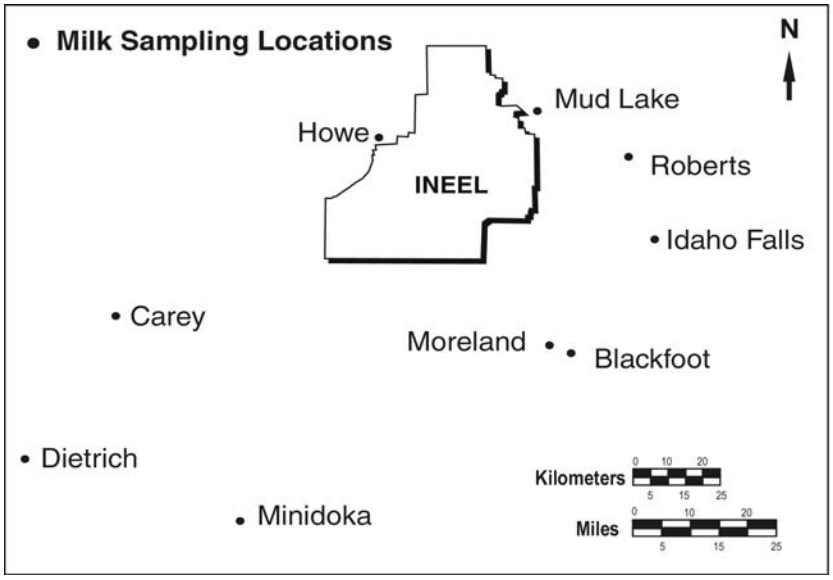

Figure 12. ESER Program milk sampling locations.

SHEEP SAMPLING

Certain areas of the INEEL are open to grazing under lease agreements managed by the Bureau of Land Management (Figure 13). Every year ESER Program personnel collect samples of sheep that have grazed on these leased areas, either just before or shortly after the sheep leave the INEEL. This occurs during the second quarter of the year. For the calendar year 2002, sheep were collected from the selected INEEL allotments before they were moved off site. Three flocks were sampled, including a control flock in Dubois from the Experimental Sheep Station, a flock from a southern INEEL allotment, and a flock from a northern INEEL

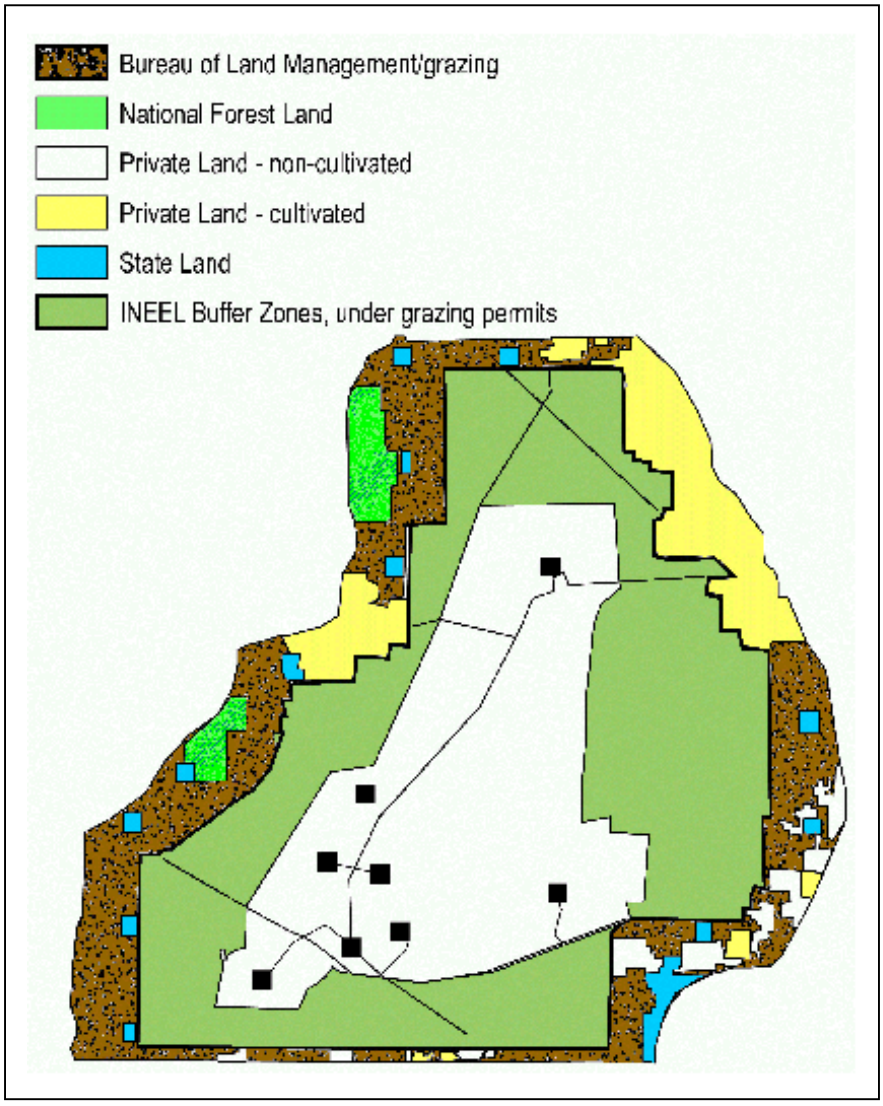

Figure 13. Grazing and land ownership on and around the INEEL.

allotment. Two sheep were taken from each flock for tissue analysis. Thyroid, muscle, and liver tissue were collected and analyzed for gamma emitting radionuclides.

Levels of ^{131}I are of particular interest in thyroids because of this organ's ability to accumulate iodine. No ^{131}I was found in any of the samples.

Analysis for ^{137}Cs showed results greater than the 2s analytical uncertatinty in three samples from three different sheep: one liver sample collected from the Northern allotment animal on May 14, and two muscle samples collected May 15, from sheep off the Southern allotment. All concentrations of ^{137}Cs were similar to those found in both onsite and offsite sheep samples during recent years. Data for all sheep samples are listed in Appendix C, Table C-10.

LARGE GAME ANIMAL SAMPLING

No large game animals were sampled during the second quarter of 2002.

6. ENVIRONMENTAL RADIATION

An array of thermoluminescent dosimeters (TLDs) is distributed throughout the Eastern Snake River Plain to monitor for environmental radiation (Figure 14). TLDs are changed out in May and again in November after six months in the field. The results of the spring sampling of TLDs exposed from November 2001 to May 2002 are discussed below.

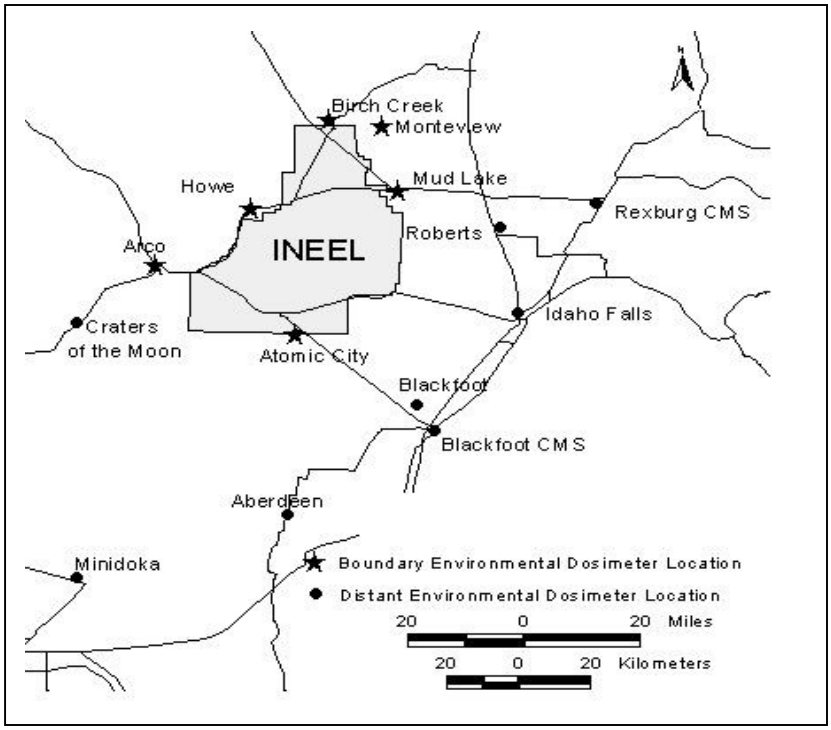

Figure 14. TLD sampling locations.

Dosimeter locations are divided into Boundary and Distant groupings. Boundary average exposure rates ranged from a low of 0.30 mR/day at Reno Ranch/Birch Creek and Blue Dome to a high of 0.38 mR/day at Mud Lake. The overall Boundary average was 0.33 mR/day. The Distant group had a high of 0.41 mR/day at Aberdeen and a low of 0.30 mR/day at the Minidoka location. The overall average Distant value was 0.34 mR/day. There was no statistical difference between Boundary and Distant locations. Furthermore, all values are consistent with past readings. Table 4 lists the range and average for both groups over a six-month period. All results are listed in Appendix C, Table C-11.

Table 4. TLD Exposures from November 2001 to May 2002.

	Total Exposure[a]	
Location	**Boundary**	**Distant**
Average	56.88	60.11
Maximum	66.50	72.40
Minimum	51.70	52.80

a All values shown are in milliroetgens (mR).

7. SUMMARY AND CONCLUSIONS

There were no statistical differences between gross alpha or gross beta concentrations in air between INEEL, Boundary and Distant locations. Levels of specific radionuclides detected in composited air filters (^{239,240}Pu and ^{241}Am) and in atmospheric moisture samples (tritium) were well below regulatory guidelines set by both the DOE and the EPA for protection of the public and were not different from values measured historically at other locations across the United States.

Tritium was not detected in any precipitation sample collected during the second quarter. Tritium and gross alpha activity were not detected in any surface water sample collected during the second quarter. Gross beta activity was detected in three of five surface water samples collected. However, levels were below the DOE DCG and federal drinking water screening level

Milk sample samples collected during the second quarter had no detectable levels of ^{131}I or ^{137}Cs.

No game animal tissues were collected during the second quarter.

Sheep were collected from two INEEL grazing allotments and one control station (Dubois). Cesium-137 was detected in three samples from three different sheep: one liver sample and two muscle samples collected from the grazing allotments. All concentrations of ^{137}Cs were similar to those found in both onsite and offsite sheep samples during recent years. Iodine-131 was not detected in any thyroid samples collected.

Exposure rates, as measured using TLDs from November through May, indicate no statistical difference between Boundary and Distant locations. Furthermore, all values are consistent with past readings.

In conclusion, no radionuclides in any of the samples taken during the second quarter of 2002 could be directly linked with INEEL activities. Concentrations in all of the samples collected and analyzed during the second quarter, 2002 were similar to levels measured in the past in the INEEL environment or in other locations in the United States and were well below regulatory standards for public health.

8. REFERENCES

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APPENDIX A

SUMMARY OF SAMPLING MEDIA & SCHEDULE

Table A-1. Summary of the ESER Program's Sampling Schedule

Sample Type Analysis	Collection Frequency	LOCATIONS[a]		
		Distant	Boundary	INEEL
AIR SAMPLING				
LOW-VOLUME AIR				
Gross Alpha, Gross Beta, ^{131}I	weekly	Blackfoot, Craters of the Moon, Dubois, Idaho Falls, Jackson WY, Rexburg	Arco, Atomic City, Blue Dome, FAA Tower, Howe, Monteview, Mud Lake	Main Gate, EFS, Van Buren
Gamma Spec	quarterly	Blackfoot, Craters of the Moon, Dubois, Idaho Falls, Jackson WY, Rexburg	Arco, Atomic City, Blue Dome, FAA Tower, Howe, Monteview, Mud Lake	Main Gate, EFS, Van Buren
^{90}Sr, Transuranics	quarterly	Rotating schedule	Rotating schedule	Rotating schedule
ATMOSPHERIC MOISTURE				
Tritium	4 to 13 weeks	Blackfoot, Idaho Falls, Rexburg	Atomic City	None
PRECIPITATION				
Tritium	monthly	Idaho Falls	None	CFA
Tritium	weekly	None	None	EFS
PM-10				
Particulate Mass	every 6th day	Rexburg, Blackfoot	Atomic City	None
WATER SAMPLING				
SURFACE WATER				
Gross Alpha, Gross Beta, ^{3}H	semi-annually	Bliss, Buhl, Hagerman, Idaho Falls, Twin Falls	None	None
DRINKING WATER				
Gross Alpha, Gross Beta, ^{3}H	semi-annually	Aberdeen, Carey, Idaho Falls, Fort Hall, Moreland, Minidoka, Roberts, Shoshone, Taber	Arco, Atomic City, Howe, Monteview, Mud Lake,	None
ENVIRONMENTAL RADIATION SAMPLING				
TLDs				
Gamma Radiation	semiannual	Aberdeen, Blackfoot, Craters of the Moon, Idaho Falls, Minidoka, Rexburg, Roberts	Arco, Atomic City, Birch Creek, Howe, Monteview, Mud Lake	None
SOIL SAMPLING				
SOIL				
Gamma Spec, ^{90}Sr, Transuranics	Biennially	Blackfoot, Carey, Crystal Ice Caves, St. Anthony	Atomic City, Birch Creek, Butte City, FAA Tower, Howe, Monteview, Mud Lake (2)	None

Table A—1. Summary of the ESER Program's Sampling Schedule (continued)

Sample Type Analysis	Collection Frequency	LOCATIONS		
		Distant	**Boundary**	**INEEL**
FOODSTUFF SAMPLING				
MILK				
Gamma Spec (^{131}I)	weekly	Idaho Falls	None	None
Gamma Spec (^{131}I)	monthly	Blackfoot, Carey, Dietrich, Minidoka, Roberts, Moreland	Howe, Terreton	None
Tritium, ^{90}Sr	Semi-annually	Blackfoot, Carey, Dietrich, Idaho Falls, Minidoka, Roberts, Moreland	Howe, Terreton	None
POTATOES				
Gamma Spec, ^{90}Sr	annually	Ammon, Blackfoot, Rupert, Tabor, occasional samples across the U.S.	Arco, Howe, Monteivew, Mud Lake	None
WHEAT				
Gamma Spec, ^{90}Sr	annually	Aberdeen, Carey, Dietrich, Goveland, Idaho Falls, Menan, Minidoka, Rockford, Rupert	Arco, Howe, Monteview, Mud Lake, Terreton	None
LETTUCE				
Gamma Spec, ^{90}Sr	annually	Blackfoot, Carey, Idaho Falls	Arco, Howe, Monteview, Mud Lake	None
BIG GAME				
Gamma Spec	varies	Occasional samples across the U.S.	Boundary roads	INEEL roads
SHEEP				
Gamma Spec	annually	Dubois	None	N. INEEL, S. INEEL
WATERFOWL				
Gamma Spec, ^{90}Sr, Transuranics	annually	Mud Lake, Heise	None	Waste disposal ponds
FISH				
Gamma Spec	annually or as available	None	None	Big Lost River

a. Sampling locations may vary from year to year based on sample availability.

APPENDIX B

SUMMARY OF MDC's, DCG's, AND SDWA LIMITS

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Table B-1. Summary of Approximate Minimum Detectable Concentrations for Radiological Analyses Performed During Second quarter 2002

Sample Type	Analysis	Approximate Minimum Detectable Concentration[a] (MDC)	Derived Concentration Guide[b] (DCG)
Air (particulate filter)[e]	Gross alpha[c]	1.07×10^{-15} µCi/mL	2×10^{-14} µCi/mL
	Gross beta[d]	1.97×10^{-15} µCi/mL	3×10^{-12} µCi/mL
	Specific gamma (^{137}Cs)	1.61×10^{-16} µCi/mL	4×10^{-10} µCi/mL
	^{238}Pu	1.64×10^{-18} µCi/mL	3×10^{-14} µCi/mL
	$^{239/240}$Pu	1.10×10^{-18} µCi/mL	2×10^{-14} µCi/mL
	^{241}Am	2.10×10^{-18} µCi/mL	2×10^{-14} µCi/mL
	^{90}Sr	6.16×10^{-17} µCi/mL	9×10^{-12} µCi/mL
Air (charcoal cartridge)[e]	^{131}I	1.70×10^{-15} µCi/mL	4×10^{-10} µCi/mL
Air (atmospheric moisture)[f]	^{3}H	1.06×10^{-7} µCi/mL$_{water}$	1×10^{-7} µCi/mL$_{air}$
Air (precipitation)	^{3}H	1.14×10^{-7} µCi/mL	2×10^{-3} µCi/mL
Drinking Water	Gross Alpha	1.32 pCi/L	30 pCi/L
	Gross Beta	2.29 pCi/L	100 pCi/L
	^{3}H	1.07 pCi/L	2×10^{6} pCi/L
Surface Water	Gross Alpha	1.27 pCi/L	30 pCi/L
	Gross Beta	2.85 pCi/L	100 pCi/L
	^{3}H	1.07 pCi/L	2×10^{6} pCi/L
Milk	^{131}I	0.65 pCi/L	--
	^{137}Cs	3.25 pCi/L	--
	^{90}Sr	0.69 pCi/L	--
Potatoes	^{137}Cs	2.08 pCi/kg	--
	^{90}Sr	288.0 pCi/kg	--
Game Animal Tissue[g]	^{137}Cs	2.68 pCi/kg	--

Sample Type	Analysis	Approximate Minimum Detectable Concentration[a] (MDC)	Derived Concentration Guide[b] (DCG)
Waterfowl	^{141}Cm	48.6 pCi/kg	--
	^{137}Cs	25.1 pCi/kg	--
	^{60}Co	3.00 pCi/kg	--
	^{95}Nb	38.6 pCi/kg	--
	$^{239/240}Pu$	5.07 pCi/kg	--
	^{90}Sr	14.2 pCi/kg	--

a The MDC is an estimate of the concentration of radioactivity in a given sample type that can be identified with a 95% level of confidence and precision of plus or minus 100% under a specified set of typical laboratory measurement conditions.

b DCGs, set by the DOE, represent reference values for radiation exposure. They are based on a radiation dose of 100 mrem/yr for exposure through a particular exposure mode such as direct exposure, inhalation, or ingestion of water.

c The DCG for gross alpha is equivalent to the DCGs for $^{239,240}Pu$ and ^{241}Am.

d The DCG for gross beta is equivalent to the DCGs for ^{228}Ra

e The approximate MDC is based on an average filtered air volume (pressure corrected) of 570 m^3/week.

f The approximate MDC is expressed for tritium (as tritiated water) in air, and is based on an average filtered air volume of 39 m^3, assuming an average sampling period of eight weeks.

g The approximate MDC assumes a sample size of 500 g.

APPENDIX C

SAMPLE ANALYSIS RESULTS

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APPENDIX D

STATISTICAL ANALYSIS RESULTS

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Table D-1. Results of the Kruskal-Wallace[a] statistical test between INEEL, Boundary, and Distant sample groups by month.

Parameter	H	p[b]
Gross Alpha		
Quarter	0.17	0.92
April	6.47	0.77
May	21.72	0.12
June	12.64	0.63
Gross Beta		
Quarter	0.11	0.94
April	3.24	1.00
May	4.13	1.00
June	4.71	0.99

a. See the Determining Statistical Differences of the Helpful Information section for details on the Kruskal-Wallace test and a description of each test statistic.

b. A 'p' value greater than 0.05 signifies no statistical difference between data groups.

Table D-2. Statistical difference in weekly gross alpha and gross beta concentrations measured at Boundary and Distant locations.

Parameter	Mann-Whitney U test[a]		
Week	U	Z	p[b]
Gross Alpha			
April 3rd	11	-1.43	0.15
April 10th	11	-1.42	0.15
April 17th	13.5	0.72	0.47
April 24th	20	-0.14	0.88
May 1st	18	0.43	0.67
May 8th	14	1.00	0.32
May 15th	15	-0.86	0.39
May 22nd	12.5	0.36	0.72
May 29th	13	-1.14	0.25
June 5th	18	0.43	0.67
June 12th	16	-0.24	0.81
June 19th	17	0.57	0.57
June 26th	12	-1.29	0.20
Gross Beta			
April 3rd	13.5	-1.41	0.16
April 10th	8.5	1.79	0.07
April 17th	12	0.96	0.33
April 24th	17	0.57	0.57
May 1st	19	-0.29	0.77
May 8th	7.5	.93	0.05[c]
May 15th	19	-0.29	0.77
May 22nd	19	-0.29	0.77
May 29th	18	-0.43	0.67
June 5th	15	0.86	0.39
June 12th	13.5	-0.65	0.51
June 19th	19	-0.29	0.78
June 26th	16.5	-0.64	0.52

a. See the Determining Statistical Differences of the Helpful Information section for details on the Mann-Whitney U test and a description of each test statistic.

b. A 'p' value greater than 0.05 signifies no statistical difference between data groups.

c. The ‘p’ value is exactly 0.053, which is greater than 0.05.