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Interim Radiological Scoping and Characterization Survey Report, 1963 Igloo 572 Accident (Former Medina Base), Lackland Training Annex, Lackland AFB, Texas

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March 2002

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13. ABSTRACT *(Maximum 200 words)*
On 13 November 1963, 50,000 kg of chemical high explosives detonated and destroyed igloo 572 on Medina Base Texas (now Lackland Training Annex, Lackland AFB TX). The result of the blast was a vaporization of the contents, a sizeable crater, removal of some rock strata below the igloo, with adjacent igloos unimpacted. The only known radioactive material dispersed as a result of the explosion was uranium metal that was comprised of both depleted and natural isotopic compositions. This report documents historical environmental data collected immediately after the accident and an evaluation of current site conditions based on survey guidelines in the radiological scoping and characterization workplan (IERA-SD-BR-SR-2000-0013). The current site conditions exhibited the same general pattern of contamination as that described by the historical documents, except that the activity concentrations are presently lower than that of 1963. Among the samples collected and analyzed for total uranium activity concentration, the highest was about 100 pCi/g. Among the monitored areas, those with uranium activity concentration above 50 pCi/g was limited, with most of the contaminated area having lower concenrtrations. Isotopic analyses of samples indicated that both depleted and natural isotopic compositions exist. Most of the areas surveyed are encompassed by a secured munitions storage complex, where access is restricted to personnel involved with munitions storage activities and those completing maintenance (i.e. structure repairs, lawn care, etc.) For these uses, the uranium activity concentrations existing in surface soils does not present significant health risks to personnel. The residual radioactivity may be below concentrations acceptable for residential occupancy.

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1. Introduction

a. Purpose. This report documents a radiological scoping and characterization survey for evaluation of residual radioactive materials in soils resulting from an accidental detonation of chemical high explosives (HE) on November 13, 1963. The explosion occurred in Igloo 572 at the Medina Facility on Medina Base, San Antonio TX. The survey was accomplished by the Radiation Surveillance Division of the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis (AFIERA/SDR) for the Environmental Management Flight of the Civil Engineering Squadron (37 CES/CEV), Lackland AFB TX. The survey generally followed the recommendations of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 1997).

b. Site Description. During the accident, Medina Base was a separate military installation on the southwest side of San Antonio. The Medina Facility on base was operated by Mason Hanger – Silas Mason Co., Inc. for the Atomic Energy Commission (AEC), Albuquerque Operations' San Antonio Area Office (AEC undated). The only known radioactive contaminant released from the accident was uranium (EG&G 1964). The AEC ceased management of the operation in 1965. The site is currently under control of Lackland AFB and is called the Lackland Training Annex. Igloos on the site are still being used for storage of munitions, under the control of the 651 Munitions Squadron, Air Force Material Command. Appendix A contains maps of the Annex and local area.

c. Summary of Survey Findings.

Field measurements collected with portable gamma (γ) radiation detection instruments identified both the location and approximate activity concentrations of uranium contamination. The contamination had a fan-like pattern extending from the former igloo location in a west to southwesterly direction. γ-radiation measurements were collected at a maximum distance from the igloo of about 900 meters, but the highest readings were observed at a distance of only 300 meters. With some exceptions, the same general pattern of contamination coincided with soil uranium concentrations analyzed in 1963.

Among the numerous soil samples collected on the site containing a depleted or natural uranium isotopic composition, the highest total uranium activity concentration was estimated at 50 picocuries per gram ($pCi\ g^{-1}$). Some correlation existed between soil uranium activity concentrations and γ-radiation measurements collected with portable instruments, but to a considerably lesser degree than that observed by AFIERA/SDR on other sites contaminated with uranium.

The uranium contamination present does not pose a significant risk assigned to work in the area. If other uses of the property are intended, like residential, contamination levels are in the vicinity of those deemed to be protective of health by U.S. Environmental Protection Agency (EPA) guidelines. There are no current plans to change the use of this property.

2. Historical Site Assessment

a. Historical Record of Accident.

At approximately 10:24 a.m. (CST) Wednesday, 13 November 1963, 50,500 kilograms (kg) of chemical HE detonated and destroyed Igloo 572. The igloo doors (that opened to a west by southwest direction) were blown from the facility in the initial stages of the blast. The final result of the blast was a vaporization of the igloo contents, a sizeable crater, and removal of some rock strata below the igloo (AEC undated). Off-site, windows in buildings several miles from the igloo were broken. Three handling crew personnel, moving HE materials to the interior of the igloo from an outside location, were believed to have initiated the accident (AEC undated). The cause of the accident was never identified, but speculated to be the result of an accidental mechanical contact between two HE components. Fortunately, site personnel received no serious personal injuries. The contents of adjacent igloos were not impacted.

The only known radioactive material dispersed as a result of the explosion was uranium metal (Davis 1963). Two types of uranium metal were involved in the accident: tuballoy (manufactured through separation of uranium from ore and having a natural isotopic composition) and depleted (uranium reduced in its content of the ^{235}U and ^{234}U isotopes) (EG&G 1964). The fraction of depleted uranium (DU) and tuballoy (TU) was not available for preparation of this report. Fissile materials [i.e., weapons grade plutonium (WGP) and highly enriched uranium (HEU)] were not involved in the accident.

Radiation surveys on-site and downwind from the site were accomplished immediately after the accident by Medina Facility personnel and an Air Force helicopter/Sandia Corporation team (AEC undated). Using portable α- and β/γ-radiation survey instruments, no α-radiation count rates or γ-radiation exposure rates were measured above that typical of naturally-occurring background sources (Davis 1963). Metallic fragments and unexploded high explosives were not identified as part of the debris (AEC undated). Wind direction and velocity data were obtained from the U.S. Weather Bureau, focusing downwind survey teams in a west by southwest direction to the town of La Coste (Davis 1963). La Coste, 20 miles downrange from the igloo, was specifically targeted for survey because the dust/debris cloud was observed to be quite heavy near the ground (Davis 1963).

Extensive follow-on aerial radiation surveys, soil samples analysis, and ground surveys were performed by federal, federal-contract, and State organizations. The results of those evaluations are summarized below.

b. EG&G Special Aerial Radiometric Survey. EG&G's Santa Barbara Laboratory performed aerial measurements at the site the day after the accident (EG&G 1964). A specially designed aircraft with a 23 cm x 7.6 cm NaI(Tl) γ-radiation detector scanned areas over the base and out to more than 25 miles from the site (EG&G 1964). The survey over Medina Base was accomplished at a height of 150 meters above ground level (AGL). The results of the aerial scan of the base are in the survey workplan (Rademacher 2000). Numerous lines were flown in the vicinity of Igloo 572 and the base perimeter. A background radiation count rate of about 300 counts per minute (cpm) was recorded. Four off-site lines were flown at 150 meters AGL following small country roads between U.S. Highway 90 from the north to U.S. Highway 81 on the south. One parallel route was flown south of U.S. Highway 81. Thirteen one-minute γ-spectra were also recorded at various downwind locations at a height of 60 meters AGL. Survey results are in the survey workplan

(Rademacher 2000b). While the survey lines had count rates above background levels, EG&G concluded that the pattern of excess count rates was not consistent with a pattern of dust fallout from an accident of this type (EG&G 1964). Evaluation of the spectral data as well appeared consistent with the background (EG&G 1964).

c. Mason Hanger - Silas Mason Co., Inc. and Sandia Corporation. Mason Hanger - Silas Mason Co., Inc. collected soil and water at both on-site and off-site locations (Kingsley 1963). The samples were analyzed through a combination of chemical extraction and liquid scintillation counting. The results of the analyses are reported in terms of micrograms of ^{238}U, with a calculation of the corresponding ^{238}U activity concentration from the author of this report. The original reference does not have details on the reported activity concentrations of the ^{234}U and ^{235}U. It is speculated that the total contaminant activity concentration (i.e. ^{234}U, ^{235}U, and ^{238}U) was attributed to ^{238}U. Table B-1 contains the results of the samples collected on-site. The activity concentrations ranged from those typical of background soil to over 700 pCi g^{-1}. These sampling results confirm that measurable concentrations of uranium contamination existed at concentrations significantly above background. It is not known if areas of the highest contamination were removed from the site at some time after the accident. Soil sampling depth was not noted in the report. Figure B (Appendix B) contains a plot of the soil sampling results, based on a Texas state plane coordinates.

d. Texas State Department of Health and Public Health Service. The Texas State Department of Health collected soils, vegetation, and water samples from off-site areas. The Public Health Service's (PHS) laboratory in Montgomery Alabama analyzed the samples (Barden 1963) with the results summarized in the workplan (Rademacher 2000). All samples were initially screened though γ-spectroscopy analysis. None of the samples had remarkable γ-ray signatures unexplained by natural background sources (SRHL 1963). The vegetation and soil samples were then ashed and a small aliquot was evaluated for total α-radiation. Water samples were filtered. Filtered media were ashed and evaluated for α-radiation content. The supernatant fraction was evaporated and evaluated for α-radiation content. Only one of the samples had α-radiation concentration deemed remarkable. This vegetation sample, SpV-9, was collected off Masterson Rd. The sample had a α-radiation activity concentration almost eight times the next highest sample. However, the soil sample collected in the same area had α-radiation levels typical of background samples. The PHS attributed the elevated α-radiation content of this sample to variability in uptake of natural radioactivity (SRHL 1963). Additional sampling in this area was not accomplished.

3. Contaminants of Concern

a. General.

Based on the historical record, the only contaminants of concern are DU and TU. Uranium, a naturally-occurring radioactive element, is silvery-white in its pure form. It is a heavy metal nearly twice as dense as lead (19 g cm^{-3}). Uranium occurs in nature in a wide variety of solid, liquid, and gaseous compounds. It readily combines with other elements to form uranium oxides, silicates, carbonates, and hydroxides. These compounds range from being highly mobile (soluble) to being relatively immobile (insoluble) in the environment.

Uranium-metal alloys are readily machinable and have metallurgical properties similar to those of high-strength steels. Finely divided uranium metal is pyrophoric (i.e., burns spontaneously in air).

Table 1 contains the isotopic composition of TU and DU. Table C-1 of Appendix C provides a partial list of nuclides and their emissions from the ^{238}U decay series. The ^{235}U decay series is listed in Table C-2.

Table 1. Characteristics of Tuballoy (TU) and Depleted Uranium (DU)* Metals.

Uranium Type	Isotopic Mixture			Specific Activity ($\mu Ci\ g^{-1}$)
	U-234	U-235	U-238	
Mass				
TU	0.0054 %	0.72 %	99.3 %	0.7
DU	0.001 %	0.2 %	99.8 %	0.4
Activity				
TU	48.9 %	2.25 %	48.9 %	0.7
DU	15.3 %	1.06 %	83.6 %	0.4

* DU isotopic composition can be highly variable dependent on the source. The example provided here is a common composition.

b. Quantification. ^{234}Th is the most readily quantifiable short-lived daughter of ^{238}U as measured in gamma spectroscopy systems. For gamma spectroscopy measurements of the soils collected from a previous AFIERA characterization study of uranium in soils (Rademacher and Hoak 2000), typical minimal detectable concentrations (MDC) were in the range of 1 pCi g^{-1}. ^{235}U emits a 0.185 MeV γ-ray with a percent yield of 57 %. This nuclide has an MDC about one-tenth that of ^{238}U (Rademacher and Hoak 2000). Some problems are encountered in the evaluation of low-activity concentration samples of ^{235}U. This is due to difficulties in differentiation of the 0.185 MeV γ-ray from ^{235}U and the 0.186 MeV γ-ray from ^{226}Ra, a decay daughter of ^{238}U. Quantification of ^{234}U activity concentrations in soils is more difficult than either ^{235}U or ^{238}U. It does not have abundant γ-ray emissions and requires analysis through chemical separation and α-spectroscopy. Therefore, α-spectroscopy is generally more accurate in determining isotopic mixes than γ-spectroscopy.

c. Background Uranium. Uranium is naturally occurring in the earth's crust. The isotopic mix is the same as that of TU as listed in Table 1. Activity concentrations of naturally occurring uranium in the earth's crust are highly variable, having some correlation to soil type. The average total uranium concentration in surface soils in the U.S. is about 2 pCi g^{-1} (Myrick 1983). The Department of Energy (Myrick 1983) investigated activity concentrations at former Manhattan Engineering District Sites and early AEC sites, including the San Antonio area. Total uranium activity concentrations ranged from 0.24 to 7.7 pCi g^{-1} among 355 samples analyzed from across the U.S. For Texas (largely the San Antonio area), the values ranged from 0.98 to 3.1 pCi g^{-1}, with a mean and standard deviation of 1.7 and 1.2, respectively.

4. AFIERA Pilot Scoping Survey On 17 May 2000, AFIERA/SDR performed a pilot scoping survey. The survey consisted of measurements with a large-area plastic scintillator mounted on the rear of a six-wheeled gasoline-fueled cart and the collection of four soil samples. Areas of elevated

γ-radiation were detected by the plastic scintillation system (results of the scanning survey not published in a report). Two soil samples were collected in areas believed to be unimpacted (i.e. background), while two were collected in areas identified by the scanning survey to have elevated γ-radiation levels. The survey locations are identified in the workplan (Rademacher 2000) with γ-spectroscopy results in Table B-2. The two flagged sampling locations had activity concentrations of ^{235}U and ^{238}U significantly elevated above background concentrations. Other reported radionuclide concentrations were typical of background. The ratio of ^{238}U to ^{235}U for the two flagged samples is noted in Table B-2 and is characteristic of DU.

5. Health Hazards Risk Evaluation

a. General. For low-level exposures, excess risk of cancer induction is the primary concern with secondary detriments including life-shortening, genetic effects, etc. Exposures of this type consist of low dose-rate external radiation and internal deposition of radioactive materials. For higher levels of exposure and in occupational exposure conditions, chemical toxicity is the primary health hazard.

b. Regulatory Authority.

The uranium involved in this accident is categorized under the Atomic Energy Act (AEA) of 1954 as a Section 91 exempt material and is not subject to regulation by the Nuclear Regulatory Commission (NRC). Regulation of the material within the Department of Defense (DoD) is delegated to the Commander of the Air Force Safety Center (HQ AFSC) (see Air Force Instruction 40-201, *Managing Radioactive Materials in the Air Force*). For unrestricted public release of former radioactive material use facilities, HQ AFSC follows industry-accepted standards, guidelines, and applicable environmental regulations under the Federal Facilities Compliance Act of 1992. Under the AEA and Reorganization Plan No. 3 of 1970, the Environmental Protection Agency (EPA) is authorized to issue Federal guidance on radiation protection matters as deemed necessary by the Agency or as mandated by Congress. This authority may be delegated to the States.

The NRC sets limits for the unrestricted release of sites with residual licensed radioactive materials. Generic site release criteria are based on an allowable dose equivalent of 25 mrem y^{-1} above background from residual radioactive contamination and the as low as reasonably achievable (ALARA) principle. For occupational exposed individuals, exposure limits are considerably higher.

The EPA proposed a draft rule for allowable dose equivalent from residual radioactive materials. The criteria included a 15 mrem y^{-1} above background upper bound. This rule was never enacted, but was later issued in similar form as non-binding guidance for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. This guidance with the ALARA principle has been applied to other Air Force Section 91 sites (Rademacher and Renaghan 2000).

c. Preliminary Remediation Goals (PRGs).

1) General. Estimates of exposure to individuals from residual radioactive materials in soils is a complex issue that is dependent on many factors to include contaminant concentrations, depth distribution of the contaminant, size of the contaminated area, chemical properties of the contaminant and soils, land use, occupancy, and many others. Usually, land areas designated for

unrestricted public use are more restricted in allowable residual radioactive materials compared to industrial sites. Though this site is not planned for unrestricted public release, it is prudent to consider long-term use scenarios if remediation efforts are planned. This report provides estimated PRGs for unrestricted public and industrial use scenarios.

2) Computer Calculated Risk Assessment.

RESRAD (Yu *etal* 1993) is a computer code specially designed to model radiation exposure to individuals from radioactive materials in environmental media. The computer code is widely accepted in the radiation protection industry and by federal regulatory bodies and many states. Appendix D contains a tabular summary of RESRAD calculations performed for DU and TU contaminants with variable land area and contaminated zone thickness; all other parameters were set to the default for the code. For the industrial exposure scenario, the inhalation and external γ-radiation routes were only considered. Table D-1 contains dose conversion guideline values (DCGL's) based on a residual dose-equivalent rate of 15 mrem y^{-1}. $DCGL_W$ values are those applied for residual radioactivity that is evenly distributed over a large area as defined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 1997).

The first six-rows of data in the Table D-1 were calculated for a DU contaminant with varying contamination zone thickness. The 10,000 m^2 area used for these calculations is the default area used in RESRAD. The dose equivalent rate is nearly inversely proportional to the contamination zone thickness.

Cases 9, 10, and 11 illustrate the effect of contamination zone area on dose-equivalent rate for a DU contaminated zone 0.15 m thick. For a 100 m^2 contamination zone, the dose-equivalent rate is 60 % of that of the default area. Subsequent case groupings (12, 13, 14, and 15) and (16, 17, 18, and 19) illustrate the effect of contamination zone area on dose-equivalent rate for 1 and 2 m thick contamination zones, respectively. The reduction in dose-equivalent rate from the default of 10,000 m^2 to 100 m^2, demonstrates the same trend as the 0.15 m thick contamination zone case, but to a much greater degree. The cases with areas less than the default are provided to illustrate projected doses from areas of elevated contamination commonly called "hot spots." In the MARSSIM approach (NRC 1997), "hot spots" are compared to special elevated measurement DCGLs ($DCGL_{EMC}$).

Table D-2 contains projected dose-equivalent rates for an industrial use scenario, where the inhalation and external γ-radiation routes were only considered. This is a reasonable assumption since drinking water sources are not derived from the site. Multiple annual exposure durations are included since the site may have considerable variation in operational use.

3) PRG Summary.

The lowest DCGL level predicted from RESRAD runs listed in Table D-1 (15 pCi g^{-1}) applies to a contamination zone of 10,000 m^2, with a two-meter thick DU contaminant. The highest DCGL level predicted from RESRAD runs listed (251 pCi g^{-1}) applies to a contamination zone of 100 m^2, with a 0.15 m thick DU contaminant. Projected dose-equivalent values for the industrial use scenarios are considerably higher than the unrestricted public use scenarios.

6. Methodology

a. Plastic Scintillator Scanning Measurements. The impacted area surrounding Igloo 572 was scanned with a plastic scintillator mounted on a gas-powered land vehicle. The instrument output response was archived by a computerized data logging system that simultaneously records vehicle location from a geographical positioning system (GPS) located on the vehicle. The instrument response is measured in the units of cpm. Circular scans about the igloo were made to assess the radiological conditions around the igloo. Areas scanned that had elevated count rate had additional measurements radially from the igloo. Scanning measurements were also collected perpendicular to the radial lines and along roads and fences of the munitions complex in a west to southwesterly direction. The results of the survey were plotted on a site map.

b. 3 x 3 NaI(Tl) Fixed In-Situ Measurements. Areas west of Igloo 572 identified by the plastic scintillator survey for the potential for contamination were measured with a 3 x 3 NaI(Tl) detection system at a fixed height of 10 centimeters (cm) above the ground surface. The detector was fitted with a flush-mounted, 1 cm thick by 7.5 cm tall steel collimator. Measurements were collected on a fixed, 10-meter square grid. The grid had GPS measurements collected at a number of points to allow plotting on GPS oriented site maps. Additional measurements were collected on the outside of the munitions complex with location fixed at measurement time with a GPS receiver. Three areas had additional grid measurements with closer spacing. Twenty-six measurements were collected along a line on the site to assess background variability within the munitions complex in an area assumed to be unimpacted based on plastic scintillator measurements. Measurements were integrated over a 30-second period and plotted on a site map. Quality assurance measurements were collected in fixed locations at the beginning and end of survey days. Since two instruments were used for surveys and the survey was accomplished over many days, some grid locations had an overlap of measurements to allow quality assurance evaluation and review.

c. Soil Sampling. Eighty-six locations had composite soil samples collected. Most locations had a collection depth of 0 – 15 cm, while a few had collection at 0 – 7.5, 7.5 – 15, 15 – 30, and 30 – 41 cm. Fifteen of the samples were collected at a background location off-site. Two background soils were also collected on-site along the line established to assess the 3 x 3 Na(Tl) background response. A stainless steel trowel or manual split-spoon sampler was used, with cleansing between samples with distilled water. Samples were double-wrapped in plastic bags with sample location annotated on a chain of custody form in waterproof ink. All samples were under constant observation or secured.

d. Laboratory Sample Analysis. All soil samples prepared for laboratory analysis were dried in an oven at 100 °C for 24 hours. The samples were blended and homogenized. Approximately 500 g aliquots were analyzed by high-resolution γ-spectroscopy in plastic Marinelli™ containers. ^{235}U and ^{238}U activity concentrations were assessed. A number of the samples had α-spectroscopy analysis to assess all three uranium isotopes.

e. Survey Personnel. Table 2 contains a listing of personnel that accomplished the field work.

Table 2. Survey Personnel.

Name	Position	Organization
Major Steven Rademacher	Health Physicist - Technical Lead	AFIERA/SDR, Brooks AFB TX
1Lt Daniel Shaw	Health Physicist – Survey Leader	AFIERA/SDRH, Brooks AFB TX
Mr Brian Renaghan	Health Physicist	AFIERA/SDRH, Brooks AFB TX
Mr Brian Saunders	Environmental Engineering Contractor	AFIERA/SDRH, Brooks AFB TX
2Lt Bruce Murren	Health Physicist	AFIERA/SDRH, Brooks AFB TX
SMSgt Troy Selden	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX
MSgt David Martin	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX
SSgt Jeff Compton	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX
SSgt Yvette Yliemieni	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX
SSgt Kimberly Murchison	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX
SrA Curtis McGehee	Bioenvironmental Engineering Technician	AFIERA/SDRH, Brooks AFB TX

7. Results

a. Plastic Scintillator Measurements.

Figure E-1 contains a plot of the plastic scintillator survey results. The group of circular measurement results on the right side of the figure represents the survey around the former location of Igloo 572. From the results, only a few of the measurements had count rates in the upper three categories of response: 1,300 – 1,900 cpm (yellow to red), lending to the conclusion that very little uranium contamination exists in the surface soils in this area. Radial measurements to the north, east and south of the igloo exhibited similar instrument count rates. The one red dot on the eastern portion of the map is at the location of the survey start; this dot does not represent actual data.

Radial measurements extending from the igloo in the west to southwesterly had clusters of elevated measurements in the 1,300 to 1,600 cpm range immediately in front of the igloo and above 1,600 cpm 250 to 350 meters from the igloo. This area was investigated in greater detail with circular patterns of measurements up to about 100 meters in diameter. This area is aligned perpendicular to the road that Igloo 572 was based.

Additional radial measurements and numerous north-south measurement lines were collected within the munitions complex to better evaluate contaminated areas. These measurements confirmed that

the greatest degree of contamination followed a pattern perpendicular to the road that Igloo 572 was based.

Measurements outside of the munitions complex were limited to areas on either side of the road on the south and west of the complex, and down range in a west by southwesterly direction along the side of roads. The ability to survey these areas was limited because they were heavily wooded except for access roads. Only two locations outside of the munitions complex had count rates in the range greater than 1,600 cpm: directly south and west of the previously identified contaminated zone within the complex. Measurements were collected along the installation's west boundary. Only one area with count rates above 1,300 cpm was identified. This area was in direct perpendicular alignment with the road that Igloo 572 was based.

b. 3 x 3 NaI(Tl) Background Measurements. Table F-1 contains a listing of the 3 x 3 NaI(Tl) measurements to assess background instrument response. Among the 26 measurements, the mean and median integrated counts were about 4,900 cpm, with a standard deviation of 663 cpm. For these values, the percent coefficient of variation (% CV) is 13.7 %. This level of variation is higher than that encountered on evaluation of sites with uranium contaminants. For one site in Indiana (Rademacher and Hoak 2000), a % CV of 2.8 % was observed. The level of variation has a direct impact on the minimum detectable concentration (MDC). Two differences between this site and the one in Indiana are believed to be the cause of the higher degree of variation observed on this site. The first is variation in elevation that creates variations in detector to source geometry. Flat sites have constant detector to source geometries, which was characteristic of the Indiana site. This site had significant variations in elevation that causes higher instrument response in low elevation areas (concave geometry) and lower instrument response in high elevation areas (convex geometry). The second source of variation may be the soil types. Some areas of the site had had surface soils comprised largely of clay materials, while others had a significant fraction of rock material.

c. 3 x 3 NaI(Tl) Grid and Other Fixed Measurements.

Figures F-1a through F-1t contain a summary of 3 x 3 NaI(Tl) grid measurement logs of the 10-meter grid survey. For each 50 by 50 meter area, annotation of the probe serial number and survey start time are provided. Measurements collected on concrete or asphalt are shaded and had the lowest integrated counts; these measurements provided meaningless information since any γ-ray emissions from contaminants would be severely attenuated. Figure E-2 contains a plot of the grid measurements as sorted by integrated count. For reference, the northernmost measurements are on the 200-meter north grid-line, with the two endpoints at 0 and 400 meters east. The measurements ranged from 3,655 to 9,706 counts. The red and orange measurements identify the contamination pattern extending from the igloo perpendicular to the road that Igloo 572 was based. This pattern corresponds well to that observed for the plastic scintillator measurements. Table F-2 contains a summary of the grid/GPS conversion calculations that were used to correlate the grid to GPS.

Figures F-2a through F-2e contain a summary of 3 x 3 (Tl) grid measurement logs of finer grid survey of hot-spot areas. The first three figures contain measurements of the hot-spot area about 300 meters from the former igloo location. This area was investigated in finer detail to determine the maximum level and variation in the contaminant. The measurements ranged from 5,012 to 10,287 counts. The second two figures contain measurements of a hot-spot area that had a soil sample analysis anomaly to be discussed later in this report. The range of 81 measurements extended from 5,789 to 7,230 counts, with a mean and standard deviation of 6,553 and 345 counts, respectively.

For the previous course grid survey measurements, among the nine measurements collected in the same area, the mean and standard deviation were 6,836 and 334 counts, respectively. Overall, for the re-evaluation of each hot-spot in finer detail, no significant differences were observed between the course and fine grid measurement sets.

Table F-3 contains a listing of the 3 x 3 NaI(Tl) measurements that were collected outside of the munitions complex. These measurements contain the GPS location and calculated equivalent grid coordinates, based on the conversion factors in Figure F-2. These measurements are also plotted on Figure E-2. Among these measurements, the maximum was 8,306 counts as compared to 10,287 counts that was observed within the munitions complex grid.

d. 3 x 3 NaI(Tl) QA/QC.

Figures G-1a through G-1v contain the daily instrument quality assurance/quality control check logs. The logs contain a listing of measurements collected at locations of relatively low and high instrument response to allow verification that the instrument was maintaining a consistent response from day to day. Instrument battery and high voltage (HV) were checked to ensure consistency. In addition, multiple measurements were collected at one location to assess instrument reliability through application of the chi-square statistical test. Daily inspection of these tests indicated that the instruments were operating properly.

Table G contains a summary of the paired in-situ 3 x 3 NaI(Tl) measurements. The table contains a summary of the paired probe, measurement date and time, measurement location, and counts. For some locations, more than two measurements were collected; for these, the location is highlighted in gray. Of the 178 paired instrument responses, 73 were of the different probe/meter combinations. Figure G-2 contains a regression plot of these responses, with the serial number of each probe annotated on the axes label. Figure G-3 contains a regression plot of the paired response for the probe with serial number 173698, with one axis being the first temporal measurement and the other being the second. Both regressions had excellent agreement in the slope factors (0.98 and 1.00) and squared correlation coefficients (0.97 and 0.97), respectively for Figures G-2 and G-3.

The descriptive statistics for the distribution of differences of paired measurements is compiled in Table 3. For the difference in response between paired measurements with the same probe, the mean difference was very small in comparison to gross counts and had a standard deviation of 191 counts.

For the distribution of differences between the measurements with different probes, the mean was - 257, indicating that there was some offset in the response of the two instruments. However, the standard deviation was similar to that of the other distribution. These distributions are important in understanding the effects of variability (variance) in measurement repeatability. The following are some factors affecting variability: random counting statistics, instrument response changes over time (i.e., temperature, voltage, etc.), and environmental changes over time affecting radiation emissions (i.e., soil moisture, humidity, cover, etc.). Theoretically, random counting statistics alone accounts for 104 counts of standard deviation (variance = 10,816) for the above data sets. This factor only accounts for about 24 to 30 % of the total variability, with the other factors accounting for the majority. Like background variability, this factor has an influence on the in-situ MDC.

Table 3. Descriptive Statistics for Difference Distributions of Paired Instrument Responses.

Parameter	Probe Serial #173698 Difference in First & Second Measurements	Difference in Probe Measurements (173698 – 173692)
Mean	-58 counts	-257 counts
Median	- 68 counts	-278 counts
Standard Deviation	191 counts	212 counts
Variance	36,481 counts^2	44,944 counts^2
Maximum	411 counts	330 counts
Minimum	-614 counts	-969 counts
Range	1,025 counts	1,299 counts
Observations	102	73

e. Soil Sampling Results.

Table E-1 contains a summary of the laboratory analysis of soil samples. The table contains sampling location grid coordinates, the Radioanalytical Branch sample identification (AFIERA/SDRR), base sampling identification number, sampling depth, 3 x 3 NaI(Tl) counts, γ-spectroscopy results, and α-spectroscopy results (if applicable). Eighty-six locations were sampled with the samples analyzed by γ-spectroscopy. Some samples also had α-spectroscopy analysis, with a number having multiple aliquot analyses.

Figure E-3 contains a scatterplot of the ^{238}U to ^{234}U activity concentration ratio vs. total uranium concentration for the α-spectroscopy data. For reference, representative ratio lines are provided for typical DU (referred here as "normal"), natural uranium metal, and highly enriched uranium (HEU). In comparison to these lines, many of the data points approximate the normal DU, but with a lesser degree of depletion. Seven of the data points have total uranium concentrations less than 2 pCi g^{-1} and are likely from background sources. As such, these points should have ratios of one, but exhibit significant variability that is common among low activity concentration samples. Two data points have activity concentrations greater than 3 pCi g^{-1} and ratios near one. While the sample near 3 pCi g^{-1} may be natural to this area, the other sample is characteristic of TU.

One sample shown in Figure E-3 did not exhibit characteristics of background, TU, or DU. Rather, this sample had a total uranium activity concentration about 220 pCi g^{-1} and an estimated ^{235}U enrichment-level of 4 % by mass [location: 180N, 370E]. To assess the apparent anomaly, three additional aliquots were examined by α-spectroscopy analyses. The three additional aliquots had good agreement in ^{238}U activity concentration to the previous α- and γ-spectroscopy analyses, but had a relationship among the three isotopes similar to other DU samples. A finer grid 3 x 3 NaI(Tl) survey of the area surrounding this sample (discussed earlier in this report) had fairly consistent measurements without observed anomalies; the analyses of two additional samples from within this finer grid (and close to the original sampling location) were not consistent with an enriched uranium.

One plausible explanation is that this anomalous aliquot contained DU, like other soils in close proximity, but also a small amount of HEU co-contaminant. The historical record of this accident discounts the presence of enriched uranium. The source of this anomaly is not known, but not believed to be an extensive condition on the site since no other sample had this characteristic.

Figure G-4 contains a regression plot of the α- and γ-spectroscopy analyses for ^{238}U. The slope of the regression and squared correlation coefficient were 0.98 and 0.91, respectively. Under consideration of the large difference in aliquots size for the respective analyses (~ 500 g for γ-spectroscopy and ~ 1 g α-spectroscopy), the agreement is good. For another site recently investigated with a weapons-related DU contaminant, similar agreement was observed (Rademacher and Hoak 2000).

f. Other Findings. Earth Technology Corp. collected soil samples on the outside of the munitions complex in December 2001 in support of a multi-site radiological sampling effort for weapons-related materials. During the survey, a 37 CES/CEV engineer discovered three small pieces of distressed metal that had detectable surface β-radiation contamination. The densities were estimated at about 7.5 g cm^{-3} (iron/steel) based on mass measurements and volume estimates. The samples had the contaminated surfaces γ-emission spectra evaluated through a high-resolution HpGe system at AFIERA/SDRR. One part was surface wiped to assess removable contamination and analyzed by gross-α and -β. The results of the analysis are summarized in Table 4. The first two samples have a composition similar to TU, while the last sample appears to be DU. Neither of the wipe samples had significant removable contamination. All of the metal parts were evaluated on contact with a Victoreen Model 450P Ion Chamber and a Bicron Surveyor M with a PGM β/γ-probe. None of the parts caused a detectable response in the ion chamber, but on the most contaminated surface of each part, the β/γ-probe measurements had: 60, 8500, and 1200 cpm response, respectively, for the parts in the same order as in the table. The parts likely originated from the igloo and were contaminated during the explosion action. AFIERA/SDRD (Special survey SP0202221A, 4 Mar 02) conducted a 21-day dosimetry study, with two dosimeters in contact with the surface of sample GS0202003. The only significant find was a shallow dose (β & γ) of 2.3 and 2.1 mrem d^{-1}. The historical record claimed that metallic parts and fragments were not part of the debris pattern in contrast to these findings. Parts of this type on the site do not present a hazard to personnel.

Table 4. High-Resolution γ–Spectroscopy and Gross-α/β Wipe Analysis of Surface-Contaminated Metal Parts (Uncertainties at 95 % Confidence Level).

Sample Identification		Activity Concentration (pCi/g)*		Sample Mass (grams)	U-238 to U-235 Activity Concentration Ratio
AFIERA/SDRR	Base	U-238	U-235		
10200014	GS0202001	1.9 ± 0.4	0.10 ± 0.06	340	19 ± 11
10200015	GS0202002	78 ± 5	3.36 ± 0. 05	290	23.2 ± 1.4
10200016	GS0202003	13.1 ± 0.9	0.24 ± 0.05	1,120	54 ± 12
		* Estimated concentration only; part geometries did not match a standard.			
		Activity per Wipe (pCi)		Note	
		Gross-α	Gross-β		
40200937	WW0202413	< 2.0	2.4 ± 0.5	~ 100 cm^2 Wipe of GS0202003	
40200938	WW0202414	1.7 ± 0.4	1.9 ± 0.4	~ 100 cm^2 Wipe of GS0202003	

8. Discussion

a. Correlation between Soil Sample Results and 3 x 3 NaI(Tl) Response.

One of the purposes of the characterization survey was to assess the response of the 3 x 3 NaI(Tl) to soil contaminant activity concentrations. Sixty-eight locations had paired soil sample and a 3 x 3 NaI(Tl) measurement. A scatterplot of the data is provided in Figure E-4. From the data, good agreement did not exist. As such, a linear regression analysis was not performed.

Other sites with uranium contaminants have provided better agreement between these two parameters. Many factors may influence this lack of good agreement. First, other sites have had higher activity concentration uranium contaminants and instrument response rates many times that of background. For this site, the highest measured count rate measured at a soil sampling location was only about twice background. Second, the terrain at this site was not uniform, providing more variability in the background response rate distribution. The standard deviation in the background count rate was 663 counts (per 30-seconds), with the upper bound of the 95 % confidence interval at about 6,300 counts. Third, as discussed earlier, there is some variability in the response of the 1) two 3 x 3 NaI(Tl) instruments at identical measurement locations and different times, and 2) for the one instrument at the same location and different times. For this factor, the standard deviation of the distribution of differences had a standard deviation of about 200 counts. A fourth factor is potential variability in the contaminant. Among the numerous locations having α-spectroscopy analysis, most were characteristic of DU, with two characteristic of TU. The difference in depletion would affect the ^{235}U concentration and in-situ γ-radiation instrument response. Other factors may be: a non-uniform distribution with respect to depth among locations on the site (possibly indicating that some areas have been physically disturbed since the accident), varying surface soil conditions, and "hot-spots."

In lieu of using linear regression analysis to estimate a conversion coefficient for the 3 x 3 NaI(Tl) to net soil ^{238}U, a simpler procedure was used. The data displayed in Figure E-4 had a sum calculated for the gross counts and ^{234}Th (surrogate for ^{238}U). The mean background (4950 counts) was multiplied by the sample number and subtracted from the summed gross counts. The same procedure was applied to the ^{234}Th (assumed background of 0.5 pCi g^{-1}) with a ratio of net counts to ^{234}Th of 424 counts-g pCi^{-1}. While this is the best estimate of a conversion coefficient from the survey data, this estimate has a greater degree of uncertainty than that estimated for other sites.

To estimate the confidence level in the coefficient, the ^{234}Th activity concentrations were randomly selected from the 68 soil sample results using Microsoft Excell™ with Crystal Ball™, a Monte-Carlo simulation add-on. One-hundred, 68-trial simulations were run, with the cumulative probability of the results in Figure G-5. The 50 % probability (426.5 counts-g pCi^{-1}) was near the mean observed from the data set, with the 90 % confidence interval extending from 316 to 586 counts-g pCi^{-1}.

b. Pattern of Deposition.

The greatest concentration of uranium contamination was located in front of the igloo along a line perpendicular to the road Igloo 572 was located. The historical record had photographs of the explosion. These photographs supported a symmetrical explosion that sent debris in all directions surrounding the igloo, but with an air-suspended dust cloud being carried in a west by southwest

direction. Off-site sampling did not detect uranium above background, lending to a reasonable conclusion that the suspended dust cloud did not cause the pattern of contamination on-site as well. Because the explosion appeared symmetrical, but created an unsymmetrical contamination pattern, it is speculated that the explosion was a two-stage event. The first stage would have been a low-order detonation, spreading contamination from within the igloo out the front doors and downrange. This stage would have initiated the second stage of the explosion that was more violent causing a complete destruction of the igloo, but causing a more symmetrical pattern of uranium contamination around the igloo. Based on the findings of the survey, the contamination created by the second stage of the explosion was considerably more diffuse than the first stage.

Three sampling locations were sampled at various depths. For two of the samples, the upper sampling level had uranium contamination higher than the lower levels, with the ^{234}Th activity concentration at the 30 – 41 cm depth within the range of background. For the other sampling location, all levels were within the range of background.

c. Comparison of Survey Results to Historical Data.

The results of this survey display the same general pattern of contamination that was documented in 1963. Over time, surface-deposited uranium will slowly migrate to greater depths and erode from the surface being displaced laterally. From the historical data, it is difficult to determine the magnitude of either of these effects because the number of soil samples collected was limited, the sampling depth is unknown, and the precision of 1963 soil sample location measurements is not known.

Some locations that had high uranium soil activity concentrations (see Figure B) did not exhibit significantly high activity concentrations in the present survey. For example, the three soil measurements along a line parallel to the road that the igloo was located had ^{238}U activity concentrations of 80, 270 and 230 pCi g^{-1} from the 1963 survey. The results of the current survey did not support the findings of 1963. It is speculated that the contaminated debris in these areas was removed to fill the hole left by the detonation. Also, the highest measured ^{238}U activity contamination in 1963 was 790 pCi g^{-1}. This sampling location was along the site boundary on the west side of the installation. Scoping measurements in this area with the plastic scintillator detected an area with count rate above background, but only moderately elevated as compared to other measurements. It is plausible that a local hot-spot was sampled in 1963 or the sampling depth was smaller than other locations, causing the result to be biased high.

d. Comparison of Survey Results to RESRAD Calculations.

Table E-2 contains a summary of in-situ 3 x 3 NaI(Tl) 2,500 m^2-grid mean count rate and standard deviation. The highest mean integrated count in a survey unit was 7,298 counts, with a standard deviation of 2,032 counts. Four other survey units had mean integrated count above 7,000 counts, 17 were between 6,000 and 7,000 counts, nine were between 5,000 and 6,000 counts, and four were below 5,000 counts. Among the survey units, the highest standard deviation among the measurements was observed in the survey unit with the highest mean count.

Based on 424 counts-g pCi^{-1} and a background count of 4,950 counts, the survey unit with the highest mean counts is estimated to have a net ^{234}Th activity concentration of 5.5 pCi g^{-1}. Using the ratios from Table 1 and assuming a DU contaminant, the total net uranium would be about 7 pCi g^{-1}.

For a TU contaminant, the total net uranium would be about 12 pCi g^{-1}. As noted earlier, due to uncertainties in the conversion coefficient, these values should be treated as a rough estimate.

The lowest DCGL for a DU contaminant for the residential exposure scenario was 15 pCi g^{-1}. This DCGL was based on a two-meter thick contamination zone. The site is likely to be below or only slightly above this level in a number of the survey units. For a more realistic contamination zone thickness (0.5 m), the DCGL for DU is 56 pCi g^{-1}. It is highly likely that the current contamination is below this level for all survey units, even with the uncertainties in the conversion coefficient. Current contamination levels are very low under the industrial exposure scenario and do not present health risks to employees.

9. Conclusions

The characterization survey confirmed the presence of DU and TU contamination extending in a fan-like pattern from the igloo in a west by southwesterly direction. The highest levels of contamination are within the munitions complex, with the highest DU and/or TU activity concentration of less than 100 pCi g^{-1}. The pattern of contamination was generally the same as that observed in 1963, except for some notable exceptions. Contamination observed in close proximity to the igloo in 1963 may have been removed after the accident; current measurements around the igloo do not indicate the existence of extensive contamination. The highest soil ^{238}U activity concentration observed in 1963 was 790 pCi g^{-1} and was located on the installation's west boundary. Current measurements in the vicinity of this location indicate the potential for contamination, but not to the degree expected based on the 1963 data. The method of soil sampling used in 1963 may have had variability between sampling locations, but no detail on the method used was provided in historical documents.

Distressed metal parts that contained surface uranium contamination were located outside of the west fence of the munitions complex. The parts appear to have originated from the igloo and were contaminated during the explosion action. The parts had γ-radiation exposure indifferentiable from background sources, but did cause response to a β-radiation detection instrument. The parts examined do not present significant radiation hazards to site personnel. Others are likely to remain on the site.

The residual uranium in the soils are at concentrations well below worker radiation standards. Personnel working on the site are exposed to insignificant levels of radiation from the contamination. The current contaminant concentrations are within limits recommended by the EPA for residential exposure based on RESRAD predictions, in-situ γ-radiation measurements, and soil sampling analysis. Some uncertainty exists in the actual residual uranium concentration due to a lack of good correlation between the in-situ γ-radiation measurements and soil sampling analysis. A more precise estimate of the residual contamination will require more soil sampling and analysis.

One soil sample had a uranium isotopic composition characteristic of enriched uranium. An aliquot analyzed by γ-spectroscopy and three additional analyzed by α-spectroscopy did not display the same characteristic, but had consistent DU concentrations. The one sampling result is believed to be an anomalous sample that had a small HEU co-contaminant that is not believed to be pervasive on the site.

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11. Abbreviations, Acronyms, Definitions

^{234}Th	thorium-234	^{234}U	uranium-234
^{235}U	uranium-235	^{238}U	uranium-238
AGL	above ground level	cm	centimeter
CI	confidence interval	CST	Central Standard Time
CV	coefficient of variation	d	day
dpm	disintigration per minute	DU	depleted uranium
E	east	γ	gamma
g	gram	ft	feet
GPS	geopositional system	HE	high explosives
HEU	highly enriched uranium	HQ	Headquarters
kg	kilogram	m	meter
$\mu g\ G^{-1}$	microgram per gram	$\mu Ci\ g$	microcuries per gram
$mg\ L^{-1}$	milligram per liter	$mrem\ d^{-1}$	millirem per day
$mrem\ y^{-1}$	millirem per year	N	north
NA	not applicable	NP	not performed
$pCi\ g^{-1}$	picocuries per gram	QA	quality assurance
QC	quality control	s	second
σ	sigma	Tl	thallium
TU	tuballoy	V	volts

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AFMC	Air Force Materiel Command
AFIERA	Air Force Institute for Environment, Safety, Occupational Health Risk Analysis
ALARA	As Low As Reasonably Achievable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DCGL	dose conversion guideline values
DoD	Department of Defense
EG&G	Edgerton, Germeshausen & Grier, Inc.
EPA	Environmental Protection Agency
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimal detectable concentration
NRC	Nuclear Regulatory Commission
PHS	Public Health Service
RESRAD	residual radiation
WGP	weapons grade plutonium
WGU	weapons grade uranium

ALARA: the practice of reducing radiation dose levels below specified limits using a cost-benefit analysis.

Curie: a unit of radioactivity equivalent to 3.7×10^{10} nuclear transformations (also referred to as disintegration) per second. One pCi is equivalent to 10^{-12} Ci or 0.037 nuclear transformations per second.

dose equivalent: for the purposes of this report, the terms dose equivalent, effective dose equivalent, and dose will be used interchangeably. The effective dose equivalent is the sum of the weighted dose equivalents for irradiated tissues or organs from ionizing radiation sources. It takes into account the different mortality risks from cancer and the risk of severe hereditary effects. A common unit for dose equivalent in the US is the mrem. For comparison to remediation criteria discussed in the report, the average American annually receives about 350 mrem from naturally occurring sources of radiation in the environment.

enriched uranium: uranium with a higher ^{235}U mass fraction than that of natural uranium.

half-life: the period of time required for any given isotope to decrease to one-half of its original quantity.

isotopes: variation in the number of neutrons in the nuclei of atoms of the same element. For example, three common isotopes of uranium: ^{234}U, ^{235}U, and ^{238}U only differ in the number of neutrons in the nucleus. Isotopes of the same element generally behave the same chemically, but can have significantly different nuclear properties (i.e., nuclear interactions and radioactivity).

minimal detectable concentration: the smallest concentration of radioactivity that can be measured under specified conditions.

radioactivity: a property exhibited by some nuclei undergoing spontaneous nuclear transformation that has accompanying radioactive particle and/or electro-magnetic emissions.

secular equilibrium: a condition where a decay product (commonly called "daughter") isotope has a very short radiological half-life compared to the radiological half-life of the "parent" isotope. In these cases, the radioactivity of the parent and daughter will be the same.

weapons grade plutonium: artificially produced type of plutonium that by mass is predominately the fissile ^{239}Pu. Fissile isotopes of elements are capable of forming critical masses of material necessary for a nuclear chain reaction.

weapons grade uranium: artificially produced type of uranium that by mass is predominantly fissile ^{235}U. Fissile isotopes of elements are capable of forming critical masses of material necessary for a nuclear chain reaction.

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Appendix A

Site Maps of Lackland Training Annex

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Figure A-1. Lackland Training Annex and Vicinity.

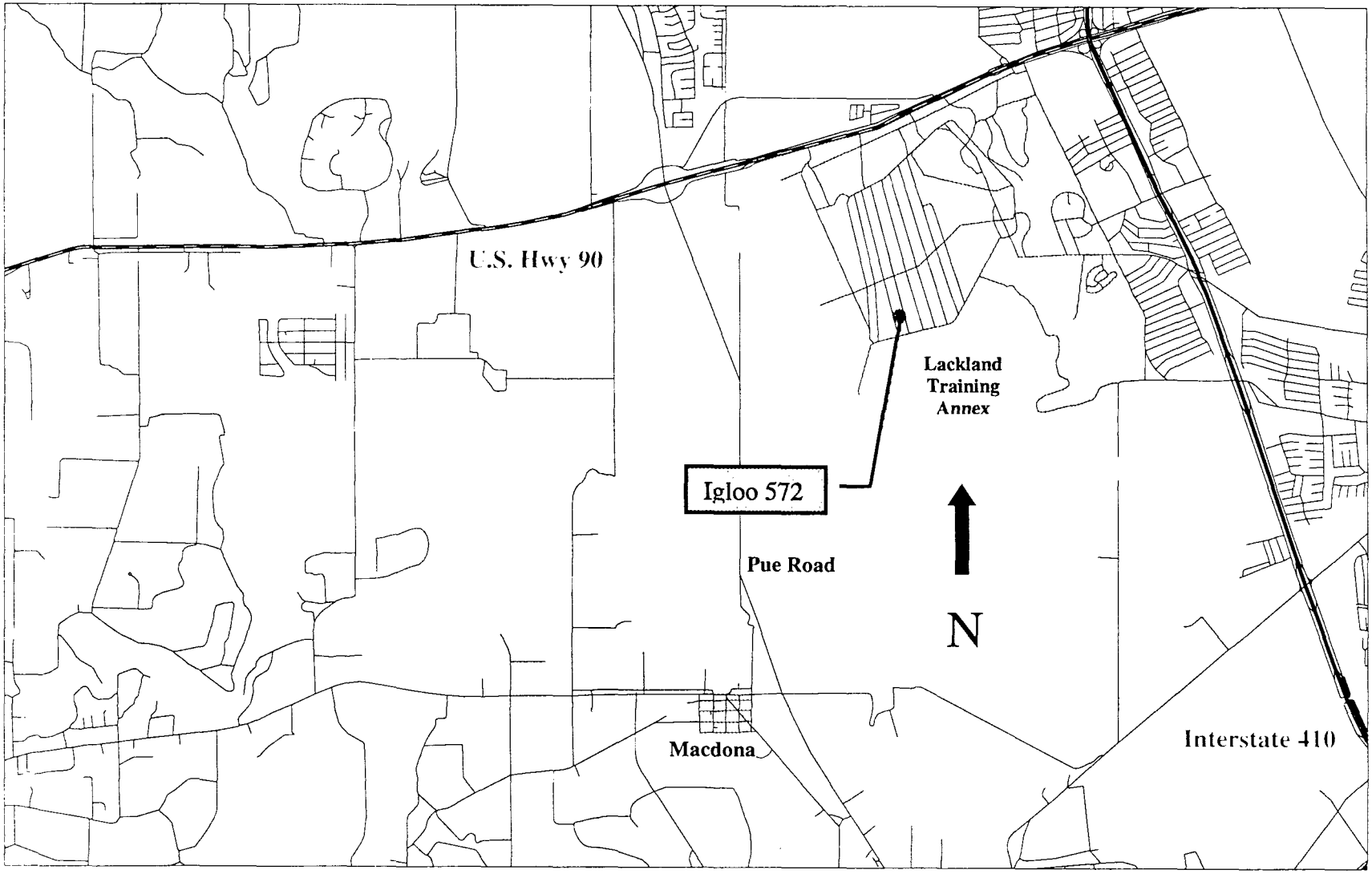
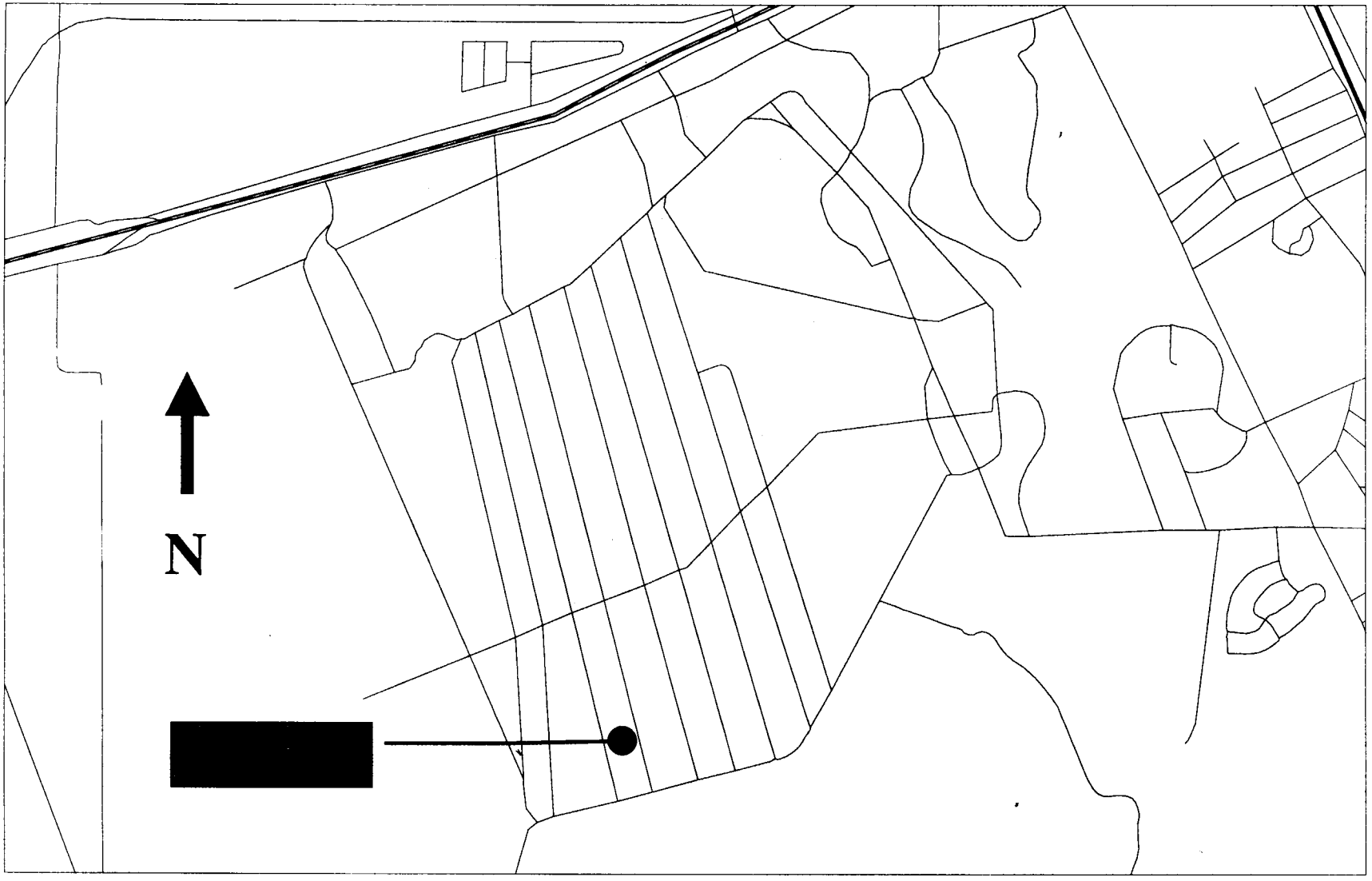


Figure A-2. Lackland Training Annex – Munitions Storage Complex.



Appendix B

Historical Site Investigation Data

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Table B-1. Atomic Energy Commission On-Site Soil Sampling Analysis Results [Immediate Vicinity of Point of the Accident] (Kingsley 1963).

Sample Number	Coordinate Locations		Net ^{238}U in Soil*	
	(East)	(North)	$\mu g\ g^{-1}$	$pCi\ g^{-1}$
1	2102600	557600	780	260
2	2102600	557200	1112	370
3	2102600	556800	1875	620
4	2101100	556500	2398	790
5	2103000	557300	284	94
6	2103800	557400	242	80
7	2103900	557000	823	270
8	2104000	556700	706	230
9	2104300	557400	7	2.3
10	2104400	557000	336	110
11	2103400	556900	1188	390
12	2102000	558000	ND	ND
13	2102000	557000	4	1.3
14	2102000	556000	26	8.6
15	2103000	556000	5	1.7
16	2104000	556000	65	21
17	2101000	558200	ND	ND
18	2101300	557200	1	0.3
19	2101500	556100	2	0.7

* Assumed Background of 2 $\mu g\ g^{-1}$ ^{238}U
ND = None Detected

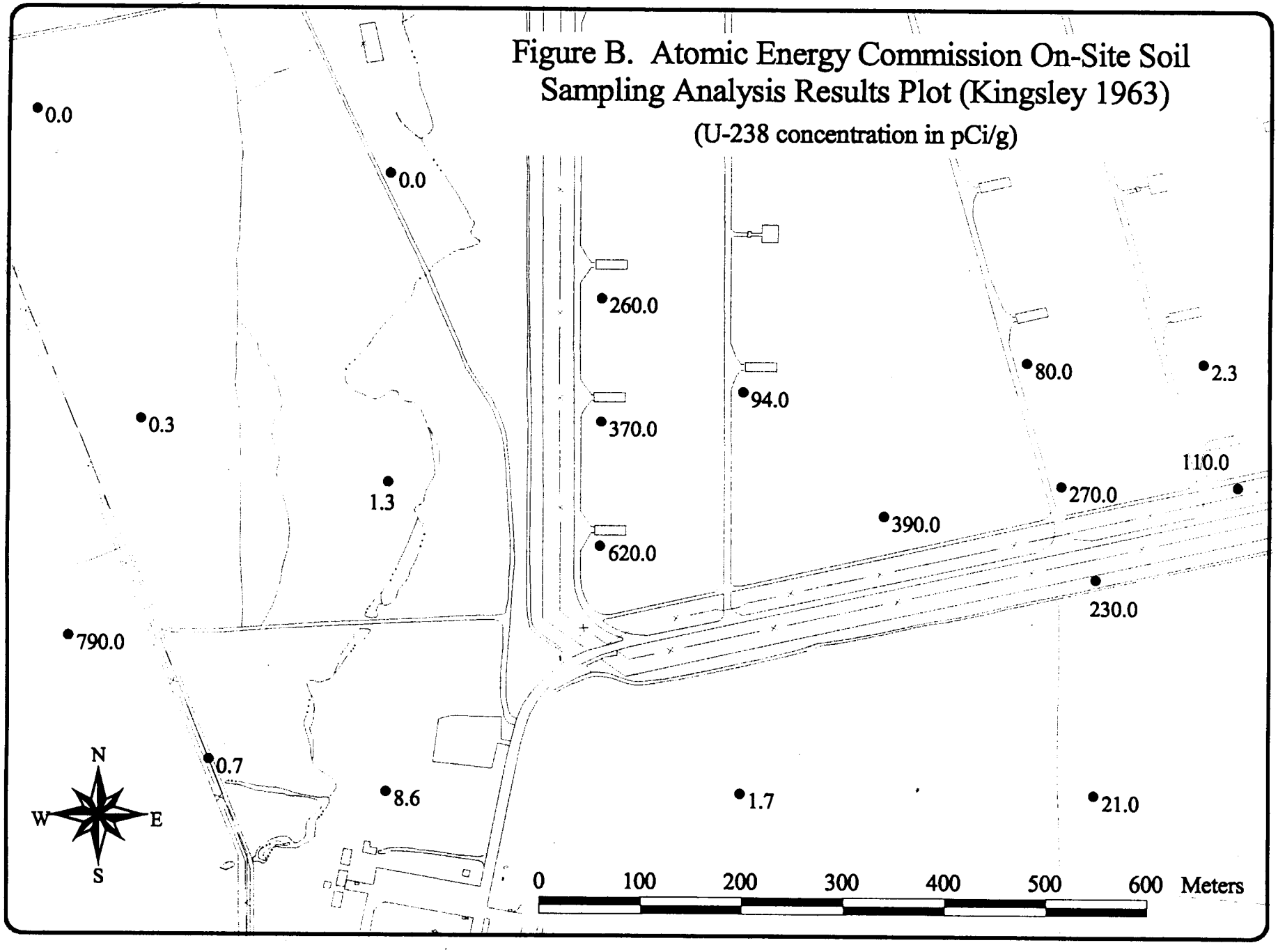

Figure B. Atomic Energy Commission On-Site Soil Sampling Analysis Results Plot (Kingsley 1963)

(U-238 concentration in pCi/g)

Table B-2. γ–Spectroscopy Results for May 2000
AFIERA/SDR Scoping Survey Soil Samples.

AFIERA/SDRR #	10000475	10000476	10000477	10000478
Sample Location	Flag 8	Flag 9	Background 1	Background 2
Isotope	Activity Concentration (pCi g^{-1}) *			
U-235	0.90 ± 0.14	1.4 ± 0.2	< 0.12	< 0.11
Th-234	37 ± 4	55 ± 6	< 1.3	< 1.3
Ra-226	< 2.9	< 3.3	3.9 ± 1.5	< 1.9
Pb-214	0.4 ± 0.2	0.31 ± 0.17	0.6 ± 0.2	0.51 ± 0.15
Bi-214	0.5 ± 0.2	0.50 ± 0.13	0.65 ± 0.17	0.58 ± 0.23
Th-232	0.4 ± 0.3	0.7 ± 0.4	0.7 ± 0.3	0.6 ± 0.3
Pb-212	0.76 ± 0.15	0.71 ± 0.19	0.45 ± 0.14	0.86 ± 0.18
Bi-212	< 0.67	< 0.70	< 0.67	< 0.64
Cs-137	0.19 ± 0.09	0.17 ± 0.08	0.23 ± 0.07	0.11 ± 0.05
Nb-95	0.24 ± 0.13	0.40 ± 0.12	NR	NR
U-238 U-235	41 ± 8	39 ± 7	I	I

* Uncertainty Levels at the 95 % Confidence Level NR = Not Reported I = Incalculable

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Appendix C

Uranium Decay Series

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Table C-1. U-238 Decay Series.

Isotope	Half-life	Radiation	Energy (MeV)	Percent Yield
^{238}U	4.5 x 10^9 y	α	4.2	75
			4.15	23
		γ	0.0496	0.07
^{234}Th	24 d	β	0.192	65
			0.100	35
		γ	0.092	4
^{234m}Pa	1.2 min	β	2.29	98
			1.53	<1
			1.25	<1
		γ	0.39	0.13
			0.817	4
^{234}U	2.5 x 10^5 y	α	4.77	72
			4.72	28
		γ	0.053	0.12

Table C-2. U-235 Decay Series.

Isotope	Half-life	Radiation	Energy (MeV)	Percent Yield
^{235}U	7.1 x 10^{8} y	α	4.32	3
			4.21	5.7
			4.58	8
			4.5	1.2
			4.4	57
			4.37	18
		γ	0.110	2.5
			0.143	11
			0.163	5
			0.185	54
			0.205	5
^{231}Th	25.64 h	β	0.302	52
			0.218	20
			0.138	22
		γ	0.026	2
			0.085	10

Appendix D

RESRAD Calculations

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Table D-1. RESRAD Calculations for Residential Exposure Scenario.

Contamination		Uranium Contaminant	Activity Concentration (pCi/g)	Dose Equivalent Rates at Specified Times Post Deposition			DCGL for 15 mrem per year for Max Dose Time	Area Factor for Dose Max Time
Zone Area (square-meters)	Zone Thickness (meters)			(t = 0) mrem/y	(t = max) mrem/y	Time @ Max (y)		
10,000	0.15	DU	1	0.095	0.095	0	158	1
10,000	0.3	DU	1	0.11	0.16	1000	94	1
10,000	0.5	DU	1	0.12	0.27	1000	56	1
10,000	1	DU	1	0.15	0.53	1000	28	1
10,000	1.5	DU	1	0.15	0.78	1000	19	1
10,000	2	DU	1	0.15	0.99	1000	15	1
10,000	2	TU	1	1.3	1.3	0	12	1
10,000	0.15	TU	1	0.076	0.076	0	197	1
10,000	0.15	DU	1	0.095	0.095	0	158	1
1,000	0.15	DU	1	0.086	0.086	0	175	1.1
100	0.15	DU	1	0.060	0.060	0	251	1.6
10,000	1	DU	1	0.15	0.53	1000	28	1
1,000	1	DU	1	0.14	0.51	1000	29	1.0
300	1	DU	1	0.089	0.45	672	33	1.1
100	1	DU	1	0.070	0.30	529	50	1.8
10,000	2	DU	1	0.15	0.99	1000	15	1
1,000	2	DU	1	0.14	0.96	1000	16	1.0
300	2	DU	1	0.089	0.72	672	21	1.4
100	2	DU	1	0.070	0.42	530	36	2.4

Table D-2. RESRAD Calculations for Industrial Exposure Scenario.

Contaminant	Zone Thickness (meters)	Annual Dose Equivalent (mrem/y) per 100 pCi/g of Uranium Soil Concentration for Various Exposure Times in Hours			
		250	500	1000	2000
DU	2	0.36	0.73	1.46	2.92
DU	1	0.36	0.73	1.46	2.91
DU	0.5	0.36	0.73	1.45	2.90
DU	0.3	0.35	0.69	1.38	2.76
TU	2	0.27	0.54	1.07	2.14
TU	1	0.25	0.50	0.99	1.98

Default parameters. Inhalation and external γ-radiation exposure routes only.

Appendix E

Survey Results

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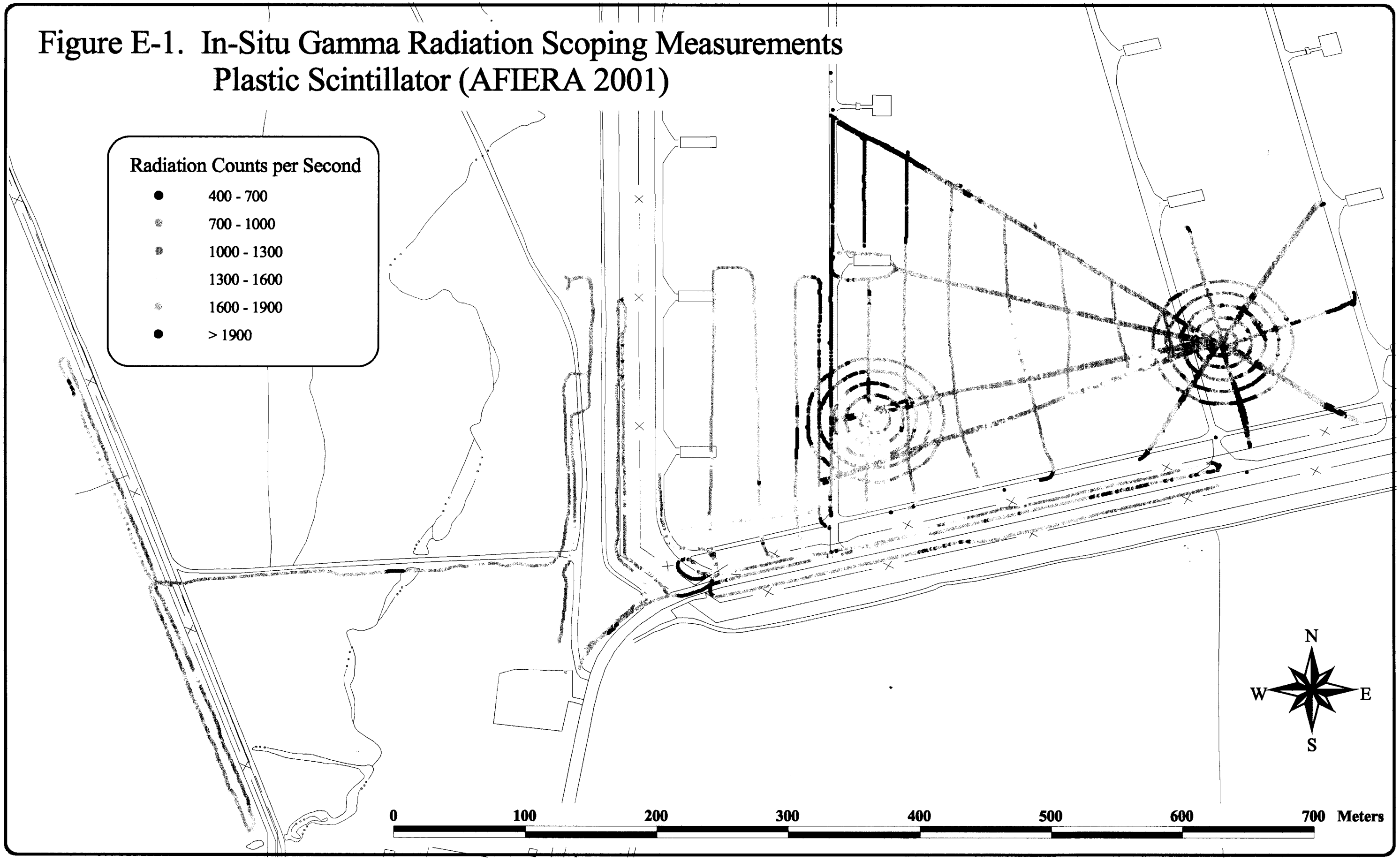
Figure E-1. In-Situ Gamma Radiation Scoping Measurements Plastic Scintillator (AFIERA 2001)



North 200m
East 0m

North 200m
East 400m

Integrated Counts
per 30 Seconds

- < 5000
- 5000 - 6000
- 6000 - 7000
- 7000 - 8000
- 8000 - 9000
- 9000 - 10000

Figure E-2. In-Situ Gamma Radiation Measurements 3 x 3 NaI(T1) (AFIERA 2001)

N
W E
S

0 100 200 300 400 500 Meters

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results.

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
Background		10100101	GS0100154	0 – 15	NP	< 0.02	0.4 ± 0.3				
Background		10100102	GS0100155	0 – 15	NP	< 0.02	0.4 ± 0.2				
Background		10100103	GS0100156	0 – 15	NP	< 0.01	0.3 ± 0.2	0.27 ± 0.06	0.03 ± 0.02	0.28 ± 0.06	0.58
Background		10100104	GS0100157	0 – 15	NP	< 0.01	0.27 ± 0.19				
Background		10100105	GS0100158	0 – 15	NP	< 0.01	0.5 ± 0.3				
Background		10100106	GS0100159	0 – 15	NP	< 0.01	0.4 ± 0.2	0.50 ± 0.11	0.11 ± 0.05	0.29 ± 0.08	0.90
Background		10100107	GS0100160	0 – 15	NP	< 0.01	0.3 ± 0.2				
Background		10100108	GS0100161	0 – 15	NP	< 0.01	0.4 ± 0.2				
Background		10100109	GS0100162	0 – 15	NP	< 0.01	0.6 ± 0.2	0.43 ± 0.09	0.09 ± 0.04	0.33 ± 0.08	0.85
Background		10100110	GS0100163	0 – 15	NP	0.06 ± 0.02	0.5 ± 0.2				
Background		10100111	GS0100164	0 – 15	NP	< 0.01	0.4 ± 0.2				
Background		10100112	GS0100165	0 – 15	NP	< 0.01	0.5 ± 0.2	0.72 ± 0.19	0.38 ± 0.15	0.40 ± 0.14	1.5
Background		10100113	GS0100166	0 – 15	NP	< 0.01	0.4 ± 0.2				
Background		10100114	GS0100167	0 – 15	NP	< 0.06	0.5 ± 0.2				
Background		10100115	GS0100168	0 – 15	NP	< 0.01	0.2 ± 0.2	1.1 ± 0.2	0.19 ± 0.08	0.38 ± 0.10	1.7
140	130	10100177	GS0100196	0 – 15	5,456	< 0.07	1.6 ± 0.2	1.7 ± 0.3	0.23 ± 0.09	1.3 ± 02	3.3
130	360	10100178	GS0100197	0 – 15	7,257	0.66 ± 0.11	32 ± 3	8.1 ± 0.8	0.80 ± 0.10	26.7 ± 0.3	36
								11.2 ± 1.2	1.1 ± 0.2	37 ± 4	50
50	390	10100179	GS0100198	0 - 15	6,446	< 0.08	1.8 ± 0.2				

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results (continued).

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
100	180	10100180	GS0100199	0 – 15	7,646	< 0.09	2.0 ± 0.3				
200	370	10100181	GS0100200	0 – 15	6,397	0.12 ± 0.07	4.9 ± 0.5	1.4 ± 0.2	0.10 ± 0.04	3.9 ± 0.4	5.4
20	260	10100182	GS0100201	0 – 15	8,375	< 0.09	2.0 ± 0.3				
10	20	10100183	GS0100202	0 – 15	5,117	< 0.08	2.0 ± 0.2				
80	50	10100184	GS0100203	0 – 15	6,435	< 0.08	1.4 ± 0.2				
120	380	10100185	GS0100204	0 – 15	7,790	0.61 ± 0.11	28 ± 3	8.6 ± 1.0	0.75 ± 0.17	30 ± 3	39
160	80	10100186	GS0100205	0 – 15	6,601	< 0.09	1.9 ± 0.3				
200	110	10100187	GS0100206	0 – 15	6,165	< 0.08	1.0 ± 0.2				
120	120	10100188	GS0100207	0 – 15	5,242	0.12 ± 0.06	3.2 ± 0.4				
90	100	10100189	GS0100208	0 – 15	5,293	< 0.07	1.8 ± 0.2				
10	80	10100190	GS0100209	0 – 15	6,886	0.11 ± 0.07	3.6 ± 0.4				
100	100	10100191	GS0100210	0 – 15	4,726	0.10 ± 0.06	1.5 ± 0.2				
180	370	10100192	GS0100211	0 - 15	7,269	0.53 ± 0.11	21 ± 2	186 ± 19	8.3 ± 1.0	26 ± 3	220
								4.8 ± 0.6	0.8 ± 0.2	17 ± 2	23
								5.8 ± 0.7	0.70 ± 0.10	21 ± 2	27
								8.2 ± 1.2	0.9 ± 0.2	26 ± 4	35
50	170	10100193	GS0100212	0 - 15	8,693	< 0.01	1.6 ± 0.2				
160	190	10100194	GS0100213	0 – 15	5,721	0.10 ± 0.07	2.7 ± 0.3	1.17 ± 0.19	0.13 ± 0.06	2.0 ± 0.3	3.3
190	170	10100195	GS0100214	0 - 15	4,242	< 0.09	1.2 ± 0.2				

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results (continued).

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
80	350	10100196	GS0100215	0 – 15	5,545	< 0.09	3.3 ± 0.4				
160	340	10100197	GS0100216	0 – 15	7,112	0.36 ± 0.08	13.0 ± 1.3	5.8 ± 0.6	0.57 ± 0.13	14.4 ± 1.4	20.7
								2.2 ± 0.3	0.30 ± 0.10	6.5 ± 0.8	9.0
130	270	10100198	GS0100217	0 – 15	7,054	0.09 ± 0.07	4.3 ± 0.5	14.7 ± 1.6	0.81 ± 0.17	17.9 ± 1.9	33
110	280	10100199	GS0100218	0 – 15	7,260	0.42 ± 0.08	16.0 ± 1.5	4.6 ± 0.6	0.37 ± 0.11	15.2 ± 1.7	20.1
70	280	10100200	GS0100219	0 – 15	8,349	0.33 ± 0.10	12.0 ± 1.2	4.1 ± 1.5	0.42 ± 0.11	14.0 ± 1.3	19
040	310	10100201	GS0100220	0 – 15	7,710	0.13 ± 0.07	4.4 ± 0.5				
110	320	10100202	GS0100221	0 – 15	7,153	0.29 ± 0.09	10.0 ± 1.0				
160	290	10100203	GS0100222	0 – 15	7,707	0.12 ± 0.07	4.2 ± 0.5				
80	320	10100204	GS0100223	0 – 15	7,106	0.13 ± 0.07	3.7 ± 0.4				
50	300	10100205	GS0100224	0 – 15	7,274	< 0.08	2.3 ± 0.3				
90	30	10100206	GS0100225	0 – 15	5,019	< 0.07	1.3 ± 0.2				
170	30	10100207	GS0100226	0 – 15	7,535	< 0.12	1.9 ± 0.3				
110	70	10100208	GS0100227	0 – 15	6,581	< 0.11	1.7 ± 0.3				
50	80	10100209	GS0100228	0 – 15	5,635	< 0.12	2.4 ± 0.4				
130	40	10100210	GS0100229	0 - 15	7,076	< 0.11	1.4 ± 0.3				
140	20	10100211	GS0100230	0 - 15	5,994	< 0.10	0.8 ± 0.2				
70	0	10100212	GS0100231	0 – 15	5,781	< 0.12	3.1 ± 0.4				
0	0	10100213	GS0100232	0 - 15	7,772	< 0.12	1.7 ± 0.3				

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results (continued).

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
200	50	10100214	GS0100233	0 – 15	6635	< 0.13	1.3 ± 0.3				
170	250	10100215	GS0100234	0 – 15	6369	< 0.11	0.7 ± 0.2	0.93 ± 0.17	0.11 ± 0.05	2.2 ± 0.3	3.3
30	180	10100216	GS0100235	0 – 15	9260	< 0.12	2.2 ± 0.3	1.6 ± 0.2	0.10 ± 0.04	0.60 ± 0.10	2.3
90	190	10100217	GS0100236	0 – 15	6655	< 0.07	1.6 ± 0.2				
10	130	10100218	GS0100237	0 – 15	9706	0.09 ± 0.08	1.7 ± 0.2	0.50 ± 0.10	0.10 ± 0.04	0.70 ± 0.10	1.3
160	120	10100219	GS0100238	0 – 15	6009	0.11 ± 0.07	1.7 ± 0.2				
40	50	10100220	GS0100239	0 – 15	7097	0.13 ± 0.06	1.7 ± 0.2				
130	240	10100221	GS0100240	0 – 15	6046	< 0.08	2.4 ± 0.3	0.40 ± 0.10	0.10 ± 0.05	2.1 ± 0.3	2.9
10	230	10100222	GS0100241	0 – 15	7555	< 0.08	1.5 ± 0.2				
50	260	10100223	GS0100242	0 – 15	7091	0.45 ± 0.10	15.0 ± 1.5	6.1 ± 0.7	0.61 ± 0.16	22 ± 2	29
50	240	10100224	GS0100243	0 – 15	7004	0.43 ± 0.08	17.0 ± 1.7	5.8 ± 0.6	0.47 ± 0.11	17.6 ± 1.7	23.9
150	200	10100225	GS0100244	0 – 15	6078	< 0.07	1.6 ± 0.2				
130	210	10100226	GS0100245	0 – 15	5557	0.16 ± 0.07	3.2 ± 0.4				
170	210	10100227	GS0100246	0 – 15	5824	< 0.12	1.6 ± 0.3				
70	220	10100228	GS0100247	0 – 15	5441	< 0.12	2.3 ± 0.3				
20	200	10100229	GS0100248	0 - 15	8851	< 0.15	2.2 ± 0.4	0.60 ± 0.10	0.10 ± 0.04	0.70 ± 0.10	1.4
60	130	10100230	GS0100249	0 - 15	7823	< 0.13	1.3 ± 0.3				
190	200	10100231	GS0100250	0 – 15	5069	< 0.14	3.1 ± 0.4				
140	190	10100232	GS0100251	0 – 15	5514	< 0.12	2.0 ± 0.3				

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results (continued).

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
130	160	10100233	GS0100252	0 – 15	3871	< 0.1	1.0 ± 0.3				
20	170	10100478	GS0100301	0 – 7.5	9253	< 0.11	1.8 ± 0.3				
		10100479	GS0100302	7.5 – 15		< 0.11	1.7 ± 0.3				
		10100480	GS0100303	15 – 30		< 0.11	1.9 ± 0.3				
		10100481	GS0100304	30 - 41		< 0.10	1.6 ± 0.2				
50	175	10100482	GS0100305	0 – 7.5	8650	< 0.16	6.6 ± 0.7				
		10100483	GS0100306	7.5 – 15		< 0.14	2.0 ± 0.3				
		10100484	GS0100307	15 – 30		< 0.14	4.9 ± 0.6				
		10100485	GS0100308	30 - 41		< 0.14	1.6 ± 0.3				
60	190	10100486	GS0100309	0 – 7.5	7948	< 0.14	2.9 ± 0.4				
		10100487	GS0100310	7.5 – 15		< 0.13	2.9 ± 0.4				
		10100488	GS0100311	15 – 30		< 0.12	2.2 ± 0.4				
		10100489	GS0100312	30 - 41		< 0.13	1.8 ± 0.3				
400	75	10101070	GS0100618	0 - 15	5358	0.11 ± 0.05	0.7 ± 0.5				
25	185	10101071	GS0100619	0 – 15	9239	0.13 ± 0.05	0.8 ± 0.4				
30	175	10101072	GS0100620	0 – 15	9846	0.15 ± 0.06	5.2 ± 0.6				
177.5	377.5	10101073	GS0100621	0 – 15	7182	0.39 ± 0.07	20.8 ± 1.5	3.4 ± 0.5	0.16 ± 0.07	12.0 ± 1.5	15.6
400	237.5	10101074	GS0100622	0 – 15	3927	< 0.10	< 1.1				
35	180	10101075	GS0100623	0 – 15	9221	< 0.2	3.5 ± 2.2				

Table E-1. Characterization Soil Sample α- and γ-Spectroscopy Results (continued).

Sample Location		Sample Identification		Sampling Depth (cm)	3 x 3 NaI Integrated Counts (30 s)	γ-Spectroscopy Results (pCi/g)		α-Spectroscopy Results (pCi/g)			
North	East	AFIERA/SDRR	Base			U-235	U-238	U-234	U-235	U-238	Total
177.5	365	10101076	GS0100624	0 – 15	7230	< 0.2	1.6 ± 1.0	6.4 ± 0.8	0.38 ± 0.12	22 ± 3	28.8
-86.8	37.1	10101077	GS0100625	0 – 15	8204	0.6 ± 0.2	33 ± 3				
-45.7	- 9.4	10101078	GS0100626	0 – 15	8121	0.20 ± 0.13	4.5 ± 1.1				
29.2	-31.7	10101108	GS0100641	0 – 15	NP	0.10 ± 0.02	3.4 ± 0.3				
77.3	-31.3	10101109	GS0100642	0 - 15	NP	< 0.15	2.4 ± 1.0				

NP = Not Performed

Uncertainties at the 95 % confidence levels.

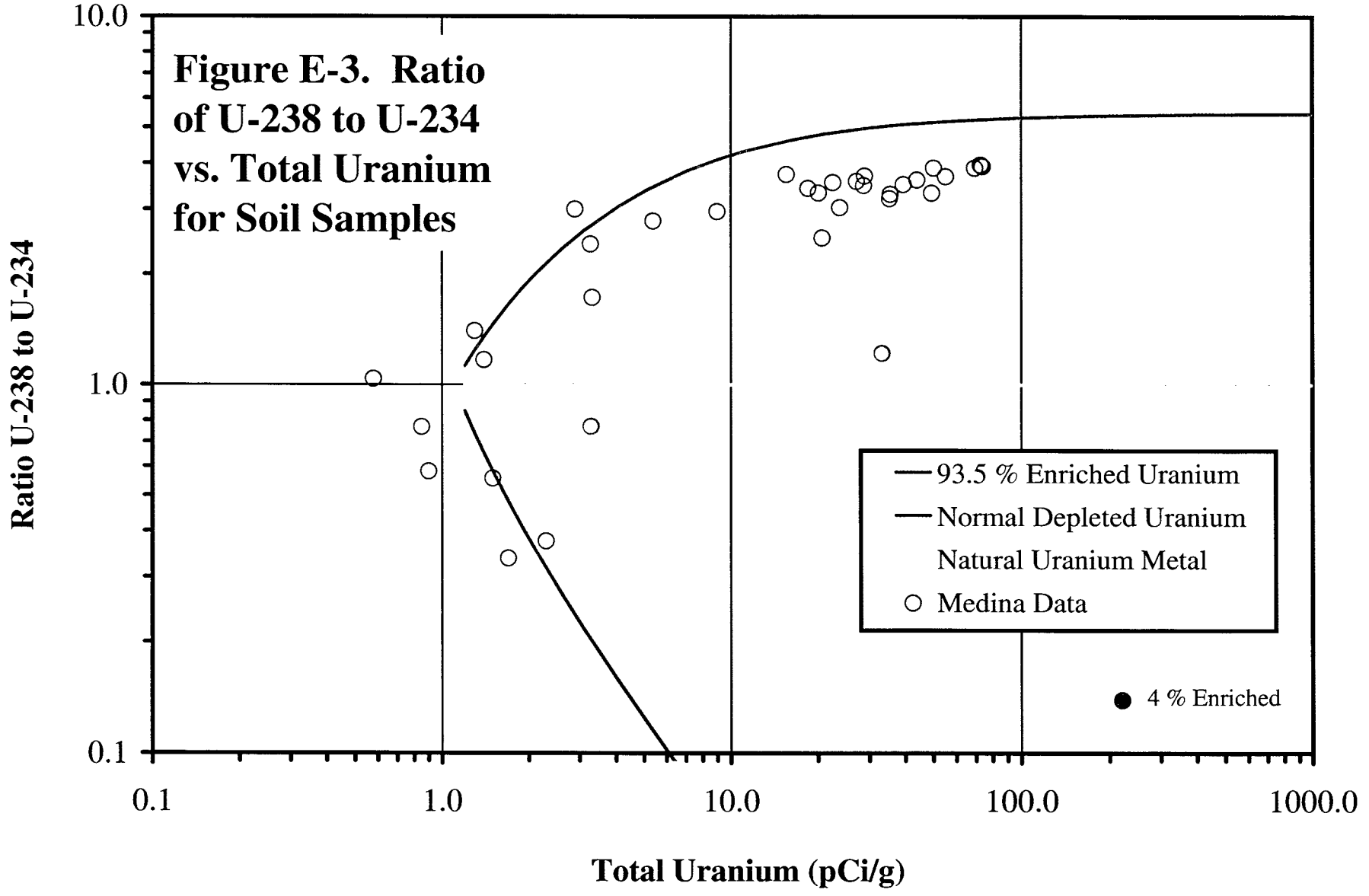


Figure E-3. Ratio of U-238 to U-234 vs. Total Uranium for Soil Samples
Ratio U-238 to U-234
10.0
1.0
0.1
0.1
1.0
10.0
100.0
1000.0
Total Uranium (pCi/g)
93.5 % Enriched Uranium
Normal Depleted Uranium
Natural Uranium Metal
Medina Data
4 % Enriched

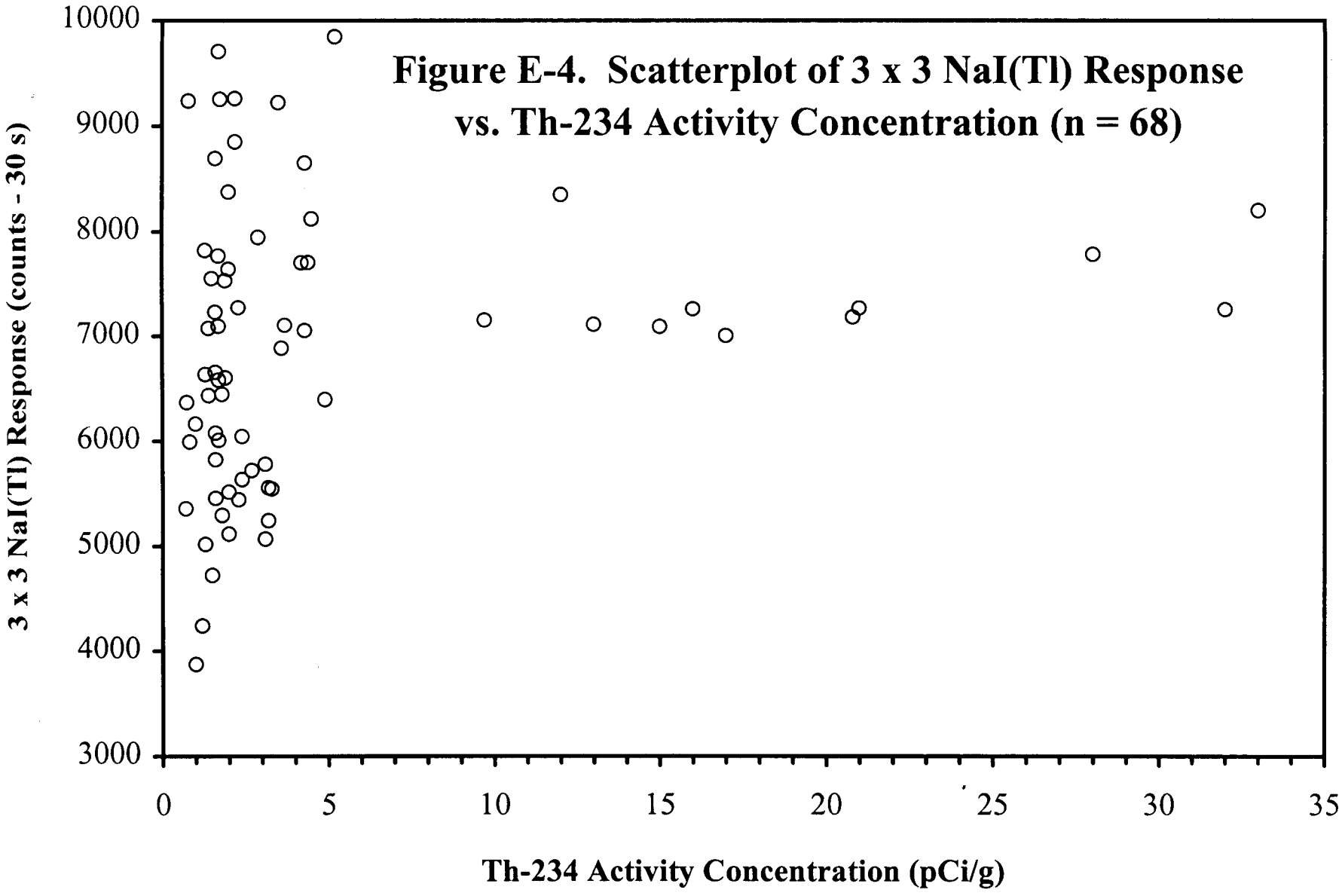


Figure E-4. Scatterplot of 3 x 3 NaI(Tl) Response vs. Th-234 Activity Concentration (n = 68)
3 x 3 NaI(Tl) Response (counts - 30 s)
10000
9000
8000
7000
6000
5000
4000
3000
0
5
10
15
20
25
30
35
Th-234 Activity Concentration (pCi/g)

Table E-2. In-Situ 3 x 3 NaI(Tl) Measurement Statistics by Survey Unit.

X Y

X = Mean Counts for Survey Unit
Y = Standard Deviation for Survey Unit

East

North	0	50	100	150	200	250	300	350	400
200	6198 1251	6462 462	5254 917	4694 695	5703 692	7123 470	6655 556	6651 735	
150	6221 1115	6323 514	4925 589	4993 861	5899 617	6964 369	7037 413	7084 1019	
100	5692 1035	5852 764	4847 1162	6321 1699	5675 862	7246 631	6119 1119	5416 880	
50	6396 1133	6624 1033	6388 1859	7298 2032	6340 1226	6785 1431	5474 1617	5421 863	
0	6813 1676	6710 1540	6129 1618						
-50									

East- West Distance in meters.

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Appendix F

Survey Logs

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Table F-1

Medina Annex - Igloo 572 Background Data Log

Survey Date: 16-Nov-01

Probe Serial Number: 173698

Survey Start Time: 10:30

	North
East	400
275	4454
262.5	4918
250	4281
237.5	3927
225	4252
212.5	4398
200	3526
187.5	4513
175	4587
162.5	4931
150	4271
137.5	5236
125	4913
112.5	5421
100	5355
87.5	5536
75	5358
62.5	5411
50	5476
37.5	5871
25	5954
12.5	NA
0	5869
East	400
	North

	North
East	400
325	4454
312.5	4918
300	4281
287.5	3927
East	400
	North

Mean = 4847.6

Median = 4915.5

Minimum = 3526

Maximum = 5954

Standard Deviation = 662.8

Percent CV = 13.7

Figure F-1a

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 13-Mar-01

Probe Serial Number: 173698

Survey Start Time: 13:30

	East						
North	0	10	20	30	40	50	North
50	6022	4958	4005	6495	7109	7629	50
40	6554	4732	4229	7212	7646	7097	40
30	6225	4858	4824	6348	6485	6051	30
20	7345	5413	4942	6408	6808	6868	20
10	6540	5619	5117	6555	6842	7111	10
0	7508	6020	4952	7567	7847	8322	0
North	0	10	20	30	40	50	North
	East						

Probe Serial Number: 173698

Survey Start Time: 14:10

	East						
North	50	60	70	80	90	100	North
50	7629	7594	5366	5749	5305	4837	50
40	7079	6490	6169	5935	4805	4437	40
30	6051	6388	6557	6098	5693	5476	30
20	6868	6527	6381	6270	6814	6815	20
10	7111	7780	7381	6886	7033	8281	10
0	8322	7589	7937	7649	7966	7496	0
North	50	60	70	80	90	100	North
	East						

Concrete or Asphalt

Figure F-1b

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 13-Mar-01

Probe Serial Number: 173698

Survey Start Time: 14:40

	East						
North	100	110	120	130	140	150	North
50	4837	4485	5043	4682	8382	4540	50
40	4437	5056	5067	4782	8502	4882	40
30	5476	5163	5079	8026	8537	4460	30
20	6815	7643	8618	9168	7484	4408	20
10	8281	8896	8989	9706	7371	4116	10
0	7496	7345	8050	5532	4051	3860	0
North	100	110	120	130	140	150	North
	East						

Concrete or Asphalt

Figure F-1c

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 16-Mar-01

Probe Serial Number: 173698

Survey Start Time: 10:25

	East						
North	150	160	170	180	190	200	North
50	4621	9235	8693	8605	8558	4397	50
40	4738	9213	9174	8839	8549	5767	40
30	4390	8975	8949	9260	9127	7383	30
20	4206	8971	9253	8996	9195	8731	20
10	3907	8112	5140	4307	4494	5105	10
0	4066	8289	8619	8068	7700	7335	0
North	150	160	170	180	190	200	North
	East						

Probe Serial Number: 173698

Survey Start Time: 12:45

	East						
North	150	160	170	180	190	200	North
100	4788	7200	5749	7641	5843	4761	100
90	3956	4259	4917	8280	6655	4455	90
80	4206	6076	6581	5829	7265	5010	80
70	4212	8406	7744	7519	7658	4378	70
60	4468	8739	5683	8195	7948	4920	60
50	4621	9235	8693	8605	8558	4397	50
North	150	160	170	180	190	200	North
	East						

Concrete or Asphalt

Figure F-1d

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 16-Mar-01

Probe Serial Number: 173698

Survey Start Time: 13:30

	East						
North	0	10	20	30	40	50	North
100	6142	4524	4454	6486	6608	6702	100
90	5880	4450	4477	5019	5774	6543	90
80	5764	4563	4178	6416	6130	6435	80
70	5781	4352	3924	6528	6998	6791	70
60	5822	4783	4162	5952	6501	6401	60
50	5836	4502	4026	6388	7169	7362	50
North	0	10	20	30	40	50	North
	East						

Probe Serial Number: 173698

Survey Start Time: 14:05

	East						
North	50	60	70	80	90	100	North
100	6702	6404	5833	5794	5370	4894	100
90	6543	6393	5974	5373	5495	5241	90
80	6435	6409	6042	5208	5364	5036	80
70	6791	6688	6121	4843	5401	4783	70
60	6401	6939	5519	5393	5339	4390	60
50	7362	7303	5141	5521	5068	4641	50
North	50	60	70	80	90	100	North
	East						

Concrete or Asphalt

Figure F-1e

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 20-Mar-01

Probe Serial Number: 173698

Survey Start Time: 10:45

	East						
North	100	110	120	130	140	150	North
100	4868	4519	4649	4324	4861	4842	100
90	5344	4746	4359	4198	5143	4011	90
80	5227	4685	4114	3566	5429	4144	80
70	4831	4235	3264	3433	5951	4351	70
60	4619	3445	4722	7823	8088	4693	60
50	4774	4493	4986	4623	8267	4514	50
North	100	110	120	130	140	150	North
	East						

Probe Serial Number: 173698

Survey Start Time: 13:20

	East						
North	150	160	170	180	190	200	North
200	3786	4413	3981	4516	3949	5104	200
190	3786	4368	4242	4495	4717	4961	190
180	3871	4993	4974	5796	5381	5233	180
170	3865	4188	5105	5191	5792	5221	170
160	4027	4598	4999	5085	5721	5438	160
150	4011	4566	5202	5171	5275	5864	150
North	150	160	170	180	190	200	North
	East						

Concrete or Asphalt

Figure F-1f

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 20-Mar-01

Probe Serial Number: 173698

Survey Start Time: 13:58

	East						
North	150	160	170	180	190	200	North
150	4011	4566	5202	5171	5275	5864	150
140	4413	3758	5063	4836	5514	5821	140
130	4217	3871	4178	4662	4261	4858	130
120	4347	4202	4445	3943	4285	4884	120
110	4281	7751	4833	4860	4617	4536	110
100	4883	7253	5902	7652	5900	4868	100
North	150	160	170	180	190	200	North
	East						

Concrete or Asphalt

Figure F-1g

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 3-Apr-01

Probe Serial Number: 173698

Survey Start Time: 10:45

	East						
North	0	10	20	30	40	50	North
150	7227	4153	6774	6940	7330	6805	150
140	7163	4284	5994	7520	6786	6943	140
130	7128	4341	4963	7113	7076	6817	130
120	6844	4614	4173	7149	6950	6894	120
110	6723	4486	4985	6582	7053	6586	110
100	6359	4883	4513	6736	6856	6788	100
North	0	10	20	30	40	50	North
	East						

Probe Serial Number: 173698

Survey Start Time: 13:20

	East						
North	0	10	20	30	40	50	North
200	6090	4487	3995	6924	6891	6668	200
190	6665	4732	4177	6184	6438	6516	190
180	6569	4546	4037	7752	7508	7473	180
170	6862	4180	4824	7535	7446	7253	170
160	7053	4023	6390	6988	7021	7121	160
150	7227	4153	6774	6940	7330	6805	150
North	0	10	20	30	40	50	North
	East						

Concrete or Asphalt

Figure F-1h

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 3-Apr-01

Probe Serial Number: 173698

Survey Start Time: 10:45

	East						
North	50	60	70	80	90	100	North
150	6805	7218	6902	6469	6607	6507	150
140	6943	6501	6526	6422	5738	6193	140
130	6817	6878	6248	6274	6318	5686	130
120	6894	6952	6644	6410	5848	5507	120
110	6586	6871	6581	6290	5857	5740	110
100	6788	6503	6154	6097	5781	4864	100
North	50	60	70	80	90	100	North
	East						

Concrete or Asphalt

Figure F-1i

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173692

Survey Start Time: 9:36

	East						
North	0	10	20	30	40	50	North
0	8036	6421	4939	8110	8144	8262	0
-10	8483	7373	4195	7769	7831	8889	-10
-20	8319	8825	4097	6592	7593	6046	-20
-30		8182	6139	4161	4543	7764	-30
-40			8412	7488	4221	4523	-40
-50				8490	7294	4089	-50
North	0	10	20	30	40	50	North
	East						

Probe Serial Number: 173698

Survey Start Time: 9:38

	East						
North	50	60	70	80	90	100	North
200	6601	6281	6048	5846	5869	6097	200
190	6049	6011	6235	6257	5873	6170	190
180	7584	7471	6376	6178	6971	6067	180
170	7047	6839	6551	6140	6181	6114	170
160	6787	6800	6942	6601	6327	6053	160
150	6841	6871	6641	6079	6297	6313	150
North	50	60	70	80	90	100	North
	East						

Concrete or Asphalt

Figure F-1j

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173692

Survey Start Time: 10:05

	East						
North	50	60	70	80	90	100	North
0	8262	7757	7993	7946	8234	7630	0
-10	8889	8417	7770	7704	7582	4765	-10
-20	6046	4747	4076	4782	7851	5691	-20
-30	7764	7198	7380	7815	4547	5346	-30
-40	4523	6803					-40
-50	4089						-50
North	50	60	70	80	90	100	North
	East						

Probe Serial Number: 173698

Survey Start Time: 10:25

	East						
North	100	110	120	130	140	150	North
150	6313	6058	5562	5829	4387	3931	150
140	5880	5955	4776	5456	4261	4130	140
130	5583	5516	5159	4918	4361	4107	130
120	5220	5047	5242	4466	5038	4295	120
110	5684	4567	4704	4492	5295	4133	110
100	4642	4330	4465	4228	4917	4700	100
North	100	110	120	130	140	150	North
	East						

Concrete or Asphalt

Figure F-1k

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173692

Survey Start Time: 13:42

	East						
North	350	360	370	380	390	400	North
200	6233	6679	6397	6026	6011	4209	200
190	6000	6573	7070	6484	6718	6063	190
180	5499	6870	7269	6455	6567	7046	180
170	6045	6501	7138	7166	7073	6128	170
160	6532	5712	6908	6824	6273	6165	160
150	6558	6342	7267	8366	8955	5856	150
North	350	360	370	380	390	400	North
	East						

Probe Serial Number: 173698

Survey Start Time: 13:45

	East						
North	200	210	220	230	240	250	North
50	4285	5798	6092	6299	7004	6716	50
40	5557	6095	6203	6396	4933	6736	40
30	7377	6563	6853	7075	7393	6221	30
20	8971	7908	4086	3960	6908	7760	20
10	4491	7196	7298	7555	7154	4777	10
0	7286	4543	4839				0
North	200	210	220	230	240	250	North
	East						

Concrete or Asphalt

Figure F-11

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173698

Survey Start Time: 10:50

	East						
North	100	110	120	130	140	150	North
200	6097	6165	5826	5375	4153	3497	200
190	6170	6245	6196	5501	4451	3567	190
180	6067	6439	5406	5121	4472	3686	180
170	6114	6117	5294	6311	4618	3859	170
160	6053	5841	6009	5431	4292	3651	160
150	6313	6058	5562	5839	4387	3931	150
North	100	110	120	130	140	150	North
	East						

Probe Serial Number: 173692

Survey Start Time: 10:25

	East						
North	100	110	120	130	140	150	North
0	7630	7623	8397	6501	4502	4020	0
-10	4765	4328	6975	8466	8367	4251	-10
-20	5691	7601	7840	5685	5598	3987	-20
-30	5346						-30
-40							-40
-50							-50
North	100	110	120	130	140	150	North
	East						

Concrete or Asphalt

Figure F-1m

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173692

Survey Start Time: 14:10

	East						
North	350	360	370	380	390	400	North
150	6558	6342	7267	8366	8955	5856	150
140	7200	6846	6818	8897	8061	8037	140
130	7342	7257	7879	8268	6977	7167	130
120	8340	8094	7686	7790	6356	5009	120
110	7253	6195	4915	6508	4804	4600	110
100	7063	6769	6522	5931	6110	5757	100
North	350	360	370	380	390	400	North
	East						

Probe Serial Number: 173698

Survey Start Time: 14:12

	East						
North	200	210	220	230	240	250	North
100	4651	4818	5305	6214	6073	6536	100
90	4317	4750	4992	5204	5891	6631	90
80	4922	4362	4938	4304	6026	5990	80
70	4548	6074	5441	5923	6527	6878	70
60	4852	5863	5790	5811	6269	6825	60
50	4255	5798	6092	6299	7004	6716	50
North	200	210	220	230	240	250	North
	East						

Concrete or Asphalt

Figure F-1n

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 6-Apr-01

Probe Serial Number: 173692

Survey Start Time: 14:46

	East						
North	350	360	370	380	390	400	North
100	7063	6769	6522	5931	6110	5609	100
90	6391	6591	6135	5424	5265	5130	90
80	5714	5850	5558	4799	4892	3994	80
70	5645	4763	4697	4733	4413	4563	70
60	4302	4190	4131	3991	5507	4812	60
50	4474	5107	6175	6490	6446	4815	50
North	350	360	370	380	390	400	North
	East						

Probe Serial Number: 173698

Survey Start Time: 14:48

	East						
North	200	210	220	230	240	250	North
150	6059	5942	6361	6323	6525	6451	150
140	5928	6215	6158	6342	5944	6326	140
130	4979	5557	6079	6055	6046	5795	130
120	4772	4918	5601	6119	6185	6257	120
110	4393	5282	5954	5670	6295	6402	110
100	4651	4818	5305	6214	6073	6536	100
North	200	210	220	230	240	250	North
	East						

Concrete or Asphalt

Figure F-1o

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 10-Apr-01

Probe Serial Number: 173692

Survey Start Time: 10:00

	East						
North	200	210	220	230	240	250	North
200	5570	4467	4479	4793	4665	5999	200
190	5176	4567	5038	5212	5361	6504	190
180	5564	4945	5404	5039	5174	6372	180
170	5478	5824	6061	6018	6063	6369	170
160	5740	6223	6555	6134	6353	6506	160
150	6312	6270	6639	6532	6989	6726	150
North	200	210	220	230	240	250	North
	East						

Probe Serial Number: 173698

Survey Start Time: 10:00

	East						
North	350	360	370	380	390	400	North
50	4250	4710	5636	6202	6248	4471	50
40	5689	4431					40
30							30
20							20
10							10
0							0
North	350	360	370	380	390	400	North
	East						

Concrete or Asphalt

Figure F-1p

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 10-Apr-01

Probe Serial Number: 173692

Survey Start Time: 10:38

	East						
North	250	260	270	280	290	300	North
100	7104	7357	6906	7402	6858	7300	100
90	6992	7446	7272	7141	7741	7642	90
80	6204	7610	7471	7588	7942	7455	80
70	7148	7306	7849	8349	7787	7027	70
60	7285	7664	7359	7670	5825	7005	60
50	7120	7091	7811	5047	8190	7509	50
North	250	260	270	280	290	300	North
	East						

Probe Serial Number: 173698

Survey Start Time: 10:30

	East						
North	300	310	320	330	340	350	North
100	7203	6785	6779	7215	6634	6957	100
90	7476	6214	6416	6880	6715	6109	90
80	7412	6464	7106	6861	6101	5375	80
70	7090	6385	7061	4970	5369	5182	70
60	6682	6687	5621	4718	4856	4027	60
50	7039	6612	4389	3672	3655	4242	50
North	300	310	320	330	340	350	North
	East						

Concrete or Asphalt

Figure F-1q

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 10-Apr-01

Probe Serial Number: 173692

Survey Start Time: 10:45

	East						
North	250	260	270	280	290	300	North
150	6726	7211	7060	7020	7703	7195	150
140	6564	6781	7306	7055	7122	7333	140
130	6158	6634	7054	7266	7477	7013	130
120	6395	6339	6463	7045	6557	7045	120
110	6957	7201	7008	7260	6984	6953	110
100	7104	7357	6906	7402	6858	7300	100
North	250	260	270	280	290	300	North
	East						

Probe Serial Number: 173698

Survey Start Time: 10:55

	East						
North	300	310	320	330	340	350	North
150	7195	6881	6266	6472	6703	6208	150
140	7333	7710	6519	6947	6710	6900	140
130	7013	7402	6623	7092	7347	7096	130
120	7045	6971	6617	7368	7991	8078	120
110	6953	6888	7153	7320	7243	6813	110
100	7203	6785	6779	7215	6634	6957	100
North	300	310	320	330	340	350	North
	East						

Concrete or Asphalt

Figure F-1r

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 10-Apr-01

Probe Serial Number: 173692

Survey Start Time: 11:06

	East						
North	250	260	270	280	290	300	North
200	5999	6443	6823	7154	7357	6681	200
190	6504	6841	7180	7091	7408	7286	190
180	6372	6914	7098	7752	7293	7305	180
170	6369	7283	7186	7825	7819	7504	170
160	6506	7234	7142	7916	7707	7673	160
150	6726	7211	7060	7020	7703	7185	150
North	250	260	270	280	290	300	North
	East						

Probe Serial Number: 173698

Survey Start Time: 11:15

	East						
North	300	310	320	330	340	350	North
200	6681	6944	6810	5951	6319	5930	200
190	7286	7210	6948	6198	6476	3751	190
180	7305	7504	7145	5739	6560	5059	180
170	7504	6891	6670	6377	6519	5711	170
160	7673	7333	6289	6744	7112	6251	160
150	7195	6881	6266	6472	6703	6208	150
North	300	310	320	330	340	350	North
	East						

Concrete or Asphalt

Figure F-1s

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 10-Apr-01

Probe Serial Number: 173698

Survey Start Time: 11:40

	East						
North	300	310	320	330	340	350	North
50	7039	6612	4389	3672	3655	4242	50
40	3687	3761	7564	6599	4954	5650	40
30	8738	5943	5243				30
20							20
10							10
0							0
North	300	310	320	330	340	350	North
	East						

Concrete or Asphalt

Figure F-1t

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 11-Apr-01

Probe Serial Number: 173698

Survey Start Time: 11:40

	East						
North	250	260	270	280	290	300	North
50	7018						50
40	6739	7915	7615	7865	5102		40
30	6551	4810	4727	7854	7584		30
20	7957	8375	8085	6943	5390		20
10	4844						10
0							0
North	250	260	270	280	290	300	North
	East						

Concrete or Asphalt

Table F-2. Grid/GPS Conversion Calculations

Location	East (m)	North (m)	Latitude (degrees)	Longitude (degrees)	Altitude (feet)	North Increment (m)	Longitude Increment (degrees)	Longitude Increment (degrees per m North)	Latitude Increment (degrees)	Latitude Increment (degrees per m North)	East Increment (m)	Latitude Increment (degrees)	Latitude Increment (degrees per m East)	Longitude Increment (degrees)	Longitude Increment (degrees per m East)
1	150	400	29.36751041	-98.67674293	724	380	2.875E-05	7.565E-08	3.436E-03	9.041E-06	0	0.0		0.0	
2	225	400	29.36750323	-98.67598100	730						75	-7.178E-06	-9.570E-08	7.619E-04	1.016E-05
3	287.5	400	29.36750230	-98.67533726	729						137.5	-8.108E-06	-5.897E-08	1.406E-03	1.022E-05
4	325	400	29.36748833	-98.67496853	725						175	-2.208E-05	-1.262E-07	1.774E-03	1.014E-05
5	185	40	29.36426712	-98.67641980	705	-10	-3.000E-06	3.000E-07	-7.925E-05	7.925E-06					
6	185	50	29.36434637	-98.67641680	707	0	0.0		0.0		35	1.706E-05		3.565E-04	1.019E-05
7	150	70	29.36453118	-98.67678339	706	50	-1.171E-05	-2.343E-07	4.565E-04	9.129E-06	0	0.0		0.0	
8	150	300	29.36658797	-98.67676008	715	280	1.160E-05	4.142E-08	2.513E-03	8.976E-06					
9	150	250	29.36614431	-98.67676330	716	230	8.378E-06	3.643E-08	2.070E-03	8.998E-06					
10	150	200	29.36570321	-98.67676559	707	180	6.094E-06	3.386E-08	1.628E-03	9.047E-06					
11	150	150	29.36524130	-98.6767740	711	130	-2.317E-06	-1.782E-08	1.167E-03	8.974E-06					
12	150	100	29.36478395	-98.67676814	684	80	3.536E-06	4.420E-08	7.092E-04	8.865E-06	0	0.0		0.0	
13	150	50	29.36432931	-98.67677329	688	30	-1.608E-06	-5.361E-08	2.546E-04	8.486E-06	0	0.0		0.0	
14	150	20	29.36407473	-98.67677168	693	0	0.0		0.0		0	0.0		0.0	
15	165	20	29.36407812	-98.67661960	695						15	3.392E-06	2.261E-07	1.521E-04	1.014E-05
16	180	20	29.36407971	-98.67646189	697						30	4.983E-06	1.661E-07	3.098E-04	1.033E-05
17	200	10	29.36399877	-98.67626468	699	0	0.0		0.0						
18	200	25	29.36414965	-98.67626971	695	15	-5.039E-06	-3.359E-07	1.509E-04	1.006E-05					
19	200	50	29.36436259	-98.67626352	706	40	1.153E-06	2.882E-08	3.638E-04	9.095E-06	50	3.327E-05	6.654E-07	5.098E-04	1.020E-05
20	200	70	29.36453965	-98.67625875	698	60	5.928E-06	9.880E-08	5.409E-04	9.015E-06	50	8.469E-06	1.694E-07	5.246E-04	1.049E-05
21	250	100	29.36480336	-98.67574904	704						100	1.941E-05	1.941E-07	1.019E-03	1.019E-05
22	360	170	29.36542644	-98.67461294	699	0	0.0		0.0		0	0.0		0.0	
23	360	190	29.36560734	-98.67460722	696	20	5.722E-06	2.861E-07	1.809E-04	9.045E-06	0	0.0		0.0	
24	380	190	29.36560039	-98.67440524	703	20	5.378E-06	2.689E-07	1.759E-04	8.795E-06	20	-6.956E-06	-3.478E-07	2.020E-04	1.010E-05
25	380	170	29.36542449	-98.67441062	700	0	0.0		0.0		20	-1.953E-06	-9.764E-08	2.023E-04	1.012E-05
							Median	3.892E-08	Median	9.006E-06		Median	'5.357E-08	Median	1.018E-05
							Mean	2.096E-08	Mean	9.040E-06		Mean	6.949E-08	Mean	1.021E-05
							S.D.	1.785E-07	S.D.	4.482E-07		S.D.	2.786E-07	S.D.	1.193E-07
							% CV	851	% CV	5.0		% CV	401	% CV	1.2

Figure F-2a

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 14-Nov-01

Probe Serial Number: 173698

Survey Start Time: 11:00

	East						
North	150	155	160	165	170	175	North
40	5054	9277	9789	9268	9643	9595	40
35	5093	9118	9529	9030	9982	9681	35
30	4984	8997	9766	8969	9436	9846	30
25	5440	9773	10094	9331	9212	9820	25
20	5244	9351	9948	9694	9820	7482	20
15	4735	9674	9681	9661	9727	9624	15
North	150	155	160	165	170	175	North
	East						

Probe Serial Number: 173698

Survey Start Time: 11:30

	East						
North	150	155	160	165	170	175	North
70	5059	8651	9077	9118	8721	8620	70
65	4587	8962	9260	9300	7567	8986	65
60	5035	9091	9475	9464	8454	9331	60
55	5060	8722	9178	9160	9075	9199	55
50	4856	9594	9725	9820	9442	9577	50
45	4862	9784	10287	9445	9616	9633	45
North	150	155	160	165	170	175	North
	East						

Concrete or Asphalt

Figure F-2b

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 14-Nov-01

Probe Serial Number: 173698

Survey Start Time: 12:00

	East						
North	180	185	190	195	200		North
40	9580	9102	9136	7411	6125		40
35	9221	9697	9258	8430	6670		35
30	9690	9451	9557	8995	8053		30
25	9633	9239	9459	9530	9170		25
20	9886	9942	9688	9517	9168		20
15	9735	9195	9362	5915	5012		15
North	180	185	190	195	200		North
	East						

Probe Serial Number: 173698

Survey Start Time: 12:30

	East						
North	180	185	190	195	200		North
70	8606	8681	8507	6871	5386		70
65	8620	6778	8941	6661	5233		65
60	8915	8828	8767	6323	5421		60
55	8801	9399	9150	6857	5203		55
50	9300	9937	9324	7627	4907		50
45	9312	9474	9422	7586	5691		45
North	180	185	190	195	200		North
	East						

Concrete or Asphalt

Figure F-2c

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 16-Nov-01

Probe Serial Number: 173698

Survey Start Time: 9:30

	East						
North	360	362.5	365	367.5	370	372.5	North
182.5	5833	6756	6741	6819	6395	6528	182.5
180	6540	7020	6898	6850	6846	6695	180
177.5	6423	7194	7230	7067	6436	6135	177.5
175	6372	7161	6897	6737	5873	6819	175
172.5	5985	6396	6488	6521	6531	6797	172.5
170	5989	6356	6555	6507	6689	6904	170
North	360	362.5	365	367.5	370	372.5	North
	East						

Probe Serial Number: 173698

Survey Start Time: 9:30

	East						
North	375	377.5	380				North
182.5	6333	6328	6269				182.5
180	5789	6101	5790				180
177.5	6448	7182	6523				177.5
175	6770	6617	6661				175
172.5	6971	6751	6244				172.5
170	6772	6262	6642				170
North	375	377.5	380				North
	East						

Concrete or Asphalt

Figure F-2d

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 16-Nov-01

Probe Serial Number: 173698

Survey Start Time: 9:30

	East						
North	360	362.5	365	367.5	370	372.5	North
190	6566	6883	6883	6401	6645	6682	190
187.5	6055	6993	6920	6557	6777	6764	187.5
185	6051	6603	6868	6848	6647	6589	185
North	360	362.5	365	367.5	370	372.5	North
	East						

Probe Serial Number: 173698

Survey Start Time: 9:30

	East						
North	375	377.5	380				North
190	6503	6322	6162				190
187.5	6756	6318	6085				187.5
185	6443	6030	5999				185
North	375	377.5	380				North
	East						

Concrete or Asphalt

Figure F-2e

Medina Annex - Igloo 572 Survey Grid Data Log

Survey Date: 16-Nov-01

Probe Serial Number: 173698

Survey Start Time: 11:05

	East						
North	120	125	130	135	140	145	North
20	8235	8256	8617	8630	6476		20
15	8390	8942	9013	8516	5842		15
10	8588	8642	8604	8628	7201		10
5	8046	8234	8387	8840	5526		5
0	7931	8235	7518				0
North	120	125	130	135	140	145	North
	East						

Drainage Ditch or Culvert

Concrete or Asphalt

Table F-3. 3 x 3 NaI(Tl) In-Situ Measurements Outside of Munitions Complex

Location Number	Counts (30 s)	GPS Coordinates		Grid Coordinates (m)	
		Longitude	Latitude	North	East
1	7064	-98.67422341	29.36433709	50.9	399.7
2	5873	-98.67422897	29.36397618	10.9	399.2
3	6143	-98.67436165	29.36402009	15.8	386.2
4	7106	-98.67448141	29.36403555	17.5	374.5
5	4549	-98.67457843	29.36395027	8.1	365.0
6	5617	-98.67465095	29.36387097	-0.7	357.9
7	4835	-98.67475888	29.36388834	1.2	347.3
8	6454	-98.67488896	29.3639104	3.7	334.6
9	6067	-98.67499924	29.3638979	2.3	323.8
10	4674	-98.67505476	29.36384291	-3.8	318.3
11	5769	-98.67510103	29.36377626	-11.2	313.8
12	5128	-98.67517368	29.36379536	-9.1	306.7
13	6117	-98.67526241	29.36382161	-6.2	298.0
14	5607	-98.67533816	29.3637383	-15.4	290.6
15	6191	-98.67538825	29.36370599	-19.0	285.7
16	5395	-98.67546611	29.36372789	-16.5	278.0
17	5866	-98.6755188	29.36375059	-14.0	272.9
18	6121	-98.67559405	29.36376636	-12.3	265.5
19	6200	-98.67564975	29.36372253	-17.1	260.0
20	6299	-98.6757074	29.36363896	-26.4	254.4
21	5233	-98.67576875	29.36366073	-24.0	248.4
22	6907	-98.67586234	29.36369848	-19.8	239.2
23	5639	-98.67597857	29.36369864	-19.8	227.8
24	6381	-98.67602442	29.36363761	-26.5	223.3
25	6220	-98.67606273	29.36356998	-34.0	219.6
26	6133	-98.67618218	29.36359459	-31.3	207.9
27	7824	-98.67626387	29.36361917	-28.6	199.9
28	5283	-98.67630948	29.36353613	-37.7	195.4
29	7425	-98.67637386	29.36345924	-46.2	189.1
30	6056	-98.67646893	29.36349119	-42.7	179.8
31	7289	-98.67657059	29.36352732	-38.7	169.9
32	7690	-98.67664063	29.36352199	-39.3	163.0
33	6966	-98.67667505	29.36348762	-43.1	159.6
34	7459	-98.67677758	29.36339111	-53.8	149.6
35	6440	-98.67688373	29.36340849	-51.9	139.2
36	6490	-98.67700309	29.36342446	-50.1	127.5

Table F-3. 3 x 3 NaI(Tl) In-Situ Measurements Outside of Munitions Complex (Cont.)

Location Number	Counts (30 s)	GPS Coordinates		Grid Coordinates (m)	
		Longitude	Latitude	North	East
37	7125	-98.67708172	29.3633182	-61.8	119.8
38	5252	-98.67719192	29.36335099	-58.2	109.0
39	6687	-98.67729741	29.36337215	-55.9	98.7
40	5591	-98.67737543	29.36329402	-64.5	91.0
41	6510	-98.67745926	29.3632237	-72.3	82.8
42	7150	-98.67761005	29.36331826	-61.8	68.0
43	7237	-98.67766269	29.36316065	-79.3	62.9
44	6662	-98.67773831	29.36321062	-73.7	55.5
45	6440	-98.67779195	29.36329058	-64.9	50.2
46	7489	-98.67785289	29.36329047	-64.9	44.3
47	7260	-98.67783041	29.36319199	-75.8	46.5
48	7137	-98.67786623	29.36311736	-84.1	43.0
49	8204	-98.67792582	29.36309262	-86.8	37.1
50	7689	-98.67800654	29.36313974	-81.6	29.2
51	8025	-98.67809453	29.36318481	-76.6	20.6
52	7815	-98.67821273	29.36339021	-53.9	9.0
53	8121	-98.67820855	29.36346446	-45.7	9.4
54	8114	-98.67824531	29.36355197	-36.0	5.8
55	7484	-98.67811923	29.3635338	-38.0	18.2
56	5552	-98.67801185	29.36342856	-49.6	28.7
57	7730	-98.67825333	29.36363716	-26.6	5.0
58	6474	-98.67840799	29.36370171	-19.4	-10.1
59	7121	-98.67834487	29.36377589	-11.2	-3.9
60	6342	-98.67840804	29.36386637	-1.2	-10.1
61	6886	-98.6783463	29.36398142	11.5	-4.1
62	7265	-98.67839289	29.36408906	23.4	-8.6
63	7083	-98.67822645	29.36339225	-53.7	7.7
64	7905	-98.67826609	29.36334528	-58.9	3.8
65	8159	-98.67835246	29.36331553	-62.1	-4.7
66	6464	-98.67846431	29.36333083	-60.5	-15.6
67	6800	-98.67855394	29.36336478	-56.7	-24.4
68	7855	-98.67864411	29.36336094	-57.1	-33.2
69	7097	-98.67877133	29.36349652	-42.1	-45.7
70	7032	-98.67886163	29.36347337	-44.7	-54.5
71	6449	-98.67886298	29.36337284	-55.8	-54.7
72	6846	-98.67887162	29.36325484	-68.9	-55.5

Table F-3. 3 x 3 NaI(Tl) In-Situ Measurements Outside of Munitions Complex (Cont.)

Location Number	Counts (30 s)	GPS Coordinates		Grid Coordinates (m)	
		Longitude	Latitude	North	East
73	6997	-98.67879187	29.36319217	-75.8	-47.7
74	7049	-98.67888852	29.36306607	-89.7	-57.2
75	6574	-98.67876033	29.36298398	-98.8	-44.6
76	7168	-98.67869398	29.3629771	-99.6	-38.1
77	6493	-98.67873029	29.36289175	-109.0	-41.7
78	4317	-98.67893611	29.36274575	-125.2	-61.8
79	4977	-98.67906493	29.36277462	-122.0	-74.5
80	6512	-98.67909034	29.36281314	-117.7	-76.9
81	5213	-98.67915345	29.36283007	-115.8	-83.1
82	4143	-98.67928388	29.36272704	-127.2	-95.9
83	5436	-98.67958572	29.36265504	-135.2	-125.5
84	6425	-98.67963497	29.36271287	-128.8	-130.3
85	4730	-98.67926019	29.36245791	-157.0	-93.6
86	6631	-98.67934322	29.36218582	-187.1	-101.7
87	6229	-98.67922245	29.36221904	-183.4	-89.9
88	5619	-98.67914503	29.36223963	-181.2	-82.3
89	6855	-98.67938684	29.36048484	-375.3	-106.0
90	6815	-98.67940925	29.36061677	-360.7	-108.2
91	6189	-98.67934024	29.36080779	-339.5	-101.4
92	6270	-98.67913613	29.36132034	-282.9	-81.4
93	6801	-98.67907094	29.36164457	-247.0	-75.0
94	6963	-98.67896421	29.36197399	-210.5	-64.6
95	6919	-98.67895751	29.36206968	-200.0	-63.9
53	8306	-98.6782068	29.36347358	-44.7	9.6
49	8064	-98.6779302	29.36309142	-86.9	36.7

Baseline Grid Location	
East	150
North	50

Baseline Coordinates	
Latitude	29.36432931
Longitude	-98.67677329

degrees per meter				
North	9.040E-06	Latitude	East	5.400E-08
East	1.021E-05	Longitude	North	3.900E-08

Appendix G

Quality Assurance/Quality Control

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Figure G-1a. Daily Instrument QA/QC Check

Date: 16-Mar-01
Weather: dry/windy
Location: 150 E
250 N
Technician: Brian Renaghan

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:30	12:30	15:00
HV:	756	754	753
WINDOW	out	out	out
THRESHOLD	100	99	99
BATTERY	6	6	5.9
COUNT TIME	30 sec	30 sec	30 sec

Start Time: 9:30 Finish Time: 10:05	
Trial	Int. Count
1	3844
2	3949
3	3998
4	3773
5	3804
6	3882
7	3767
8	3882
9	3826
10	3853
11	3707
12	3730
13	3818
14	3815
15	3759
Mean:	3827.1
Expected S.D.:	61.9
Standard Dev.:	78.8
Variance:	6203
% CV:	2.06

Start Time: 12:30 Finish Time: 12:35	
Trial	Int. Count
1	3759
2	3817
3	3737
4	3740
5	3717
Mean:	3754.0
Expected S.D.:	61.3
Standard Dev.:	38.2
variance:	1462
% CV:	1.02

Start Time: 15:00 Finish Time: 15:05	
Trial	Int. Count
1	3617
2	3664
3	3637
4	3653
5	3593
Mean:	3632.8
Expected S.D.:	60.3
Standard Dev.:	28.4
Variance:	808.2
% CV:	0.78

Figure G-1b. Daily Instrument QA/QC Check

Date: 16-Mar-01
Weather: dry/windy
Location: 180 E
20 N
Technician: Brian Renaghan

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:30	12:30	15:00
HV:	756	754	753
WINDOW	out	out	out
THRESHOLD	100	99	99
BATTERY	6	6	5.9
COUNT TIME	30 sec	30 sec	30 sec

Start Time: 9:30 Finish Time: 10:05	
Trial	Int. Count
1	9033
2	8930
3	8942
4	9003
5	8830
6	9013
7	8853
8	8812
9	9137
10	8803
11	9004
12	8918
13	8809
14	8990
15	8853
Mean:	8928.7
Expected S.D.:	94.5
Standard Dev.:	100.6
Variance:	10112
% CV:	1.13

Start Time: 12:30 Finish Time: 12:35	
Trial	Int. Count
1	8854
2	8719
3	8941
4	8802
5	8837
Mean:	8830.6
Expected S.D.:	94.0
Standard Dev.:	80.7
variance:	6512.3
% CV:	0.91

Start Time: 15:00 Finish Time: 15:05	
Trial	Int. Count
1	8988
2	9062
3	8978
4	9079
5	9130
Mean:	9047.4
Expected S.D.:	95.1
Standard Dev.:	64.0
Variance:	4094.8
% CV:	0.71

Figure G-1c. Daily Instrument QA/QC Check

Date: 20-Mar-01
Weather: clear/sunny
Location: 150 E
250 N
Technician: Brian Renaghan

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:30	12:30	15:00
HV:	755	755	752
WINDOW	out	out	out
THRESHOLD	100	99	99
BATTERY	5.9	5.9	5.9
COUNT TIME	30 sec	30 sec	30 sec

Start Time: 9:30 Finish Time: 10:05	
Trial	Int. Count
1	3757
2	3924
3	3949
4	3940
5	3949
6	3852
7	3963
8	3785
9	3861
10	3863
11	3881
12	3801
13	3784
14	3925
15	3976
Mean:	3880.7
Expected S.D.:	62.3
Standard Dev.:	72.8
Variance:	5302
% CV:	1.88

Start Time: 12:30 Finish Time: 12:35	
Trial	Int. Count
1	3869
2	3814
3	3775
4	3897
5	3983
Mean:	3867.6
Expected S.D.:	62.2
Standard Dev.:	80.0
variance:	6407.8
% CV:	2.07

Start Time: 15:00 Finish Time: 15:05	
Trial	Int. Count
1	3827
2	3929
3	3910
4	3854
5	3911
Mean:	3886.2
Expected S.D.:	62.3
Standard Dev.:	43.5
Variance:	1888.7
% CV:	1.12

Figure G-1d. Daily Instrument QA/QC Check

Date: 20-Mar-01
Weather: clear/sunny
Location: 180 E
20 N
Technician: Brian Renaghan

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	10:22	13:10	14:31
HV:	755	754	751
WINDOW	out	out	out
THRESHOLD	100	99	99
BATTERY	6	6	5.8
COUNT TIME	30 sec	30 sec	30 sec

Start Time: 10:10 Finish Time: 10:25	
Trial	Int. Count
1	8960
2	9099
3	8934
4	8904
5	9163
6	9083
7	9025
8	9033
9	8985
10	9103
11	9060
12	9003
13	8945
14	8917
15	9034
Mean:	9016.5
Expected S.D.:	95.0
Standard Dev.:	76.3
Variance:	5826
% CV:	0.85

Start Time: 12:40 Finish Time: 12:45	
Trial	Int. Count
1	9117
2	9059
3	9018
4	8954
5	9088
Mean:	9047.2
Expected S.D.:	95.1
Standard Dev.:	63.7
variance:	4053.7
% CV:	0.70

Start Time: 15:00 Finish Time: 15:05	
Trial	Int. Count
1	8967
2	9125
3	9370
4	9041
5	9048
Mean:	9110.2
Expected S.D.:	95.4
Standard Dev.:	155.6
Variance:	24219.7
% CV:	1.71

Figure G-1e. Daily Instrument QA/QC Check

Date: 6-Apr-01
Weather: cloudy/humid
Location: 150 E
250 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	10:31	11:35	13:37	15:08
HV:	754	751	751	751
WINDOW	out	out	out	out
THRESHOLD	99	99	99	99
BATTERY	5.9	5.8	5.8	5.8
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 10:31	
Finish Time: 10:50	
Trial	Int. Count
1	3857
2	3799
3	3949
4	3903
5	3796
6	3743
7	3823
8	3870
9	3702
10	3842
11	3776
12	3756
13	3777
14	3873
15	3818
Mean:	3818.9
Expected S.D.:	61.8
Standard Dev.:	65.2
Variance:	4246
% CV:	1.71

Start Time: 11:35	
Finish Time: 11:40	
Trial	Int. Count
1	3860
2	3827
3	3898
4	3805
5	3851
Mean:	3848.2
Expected S.D.:	62.0
Standard Dev.:	35.2
variance:	1235.7
% CV:	0.91

Start Time: 13:37	
Finish Time: 13:42	
Trial	Int. Count
1	3830
2	3917
3	3813
4	3903
5	3823
Mean:	3857.2
Expected S.D.:	62.1
Standard Dev.:	48.8
Variance:	2384.2
% CV:	1.27

Start Time: 15:08	
Finish Time: 15:13	
Trial	Int. Count
1	3826
2	3807
3	3887
4	3914
5	3931
Mean:	3873
Expected S.D.:	62.2
Standard Dev.:	54.3
Variance:	2951.5
% CV:	1.40

Figure G-1f. Daily Instrument QA/QC Check

Date: 3-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	10:31	11:50	13:52	15:00
HV:	752	752	751	751
WINDOW	out	out	out	out
THRESHOLD	99	99	99	99
BATTERY	5.9	5.8	5.8	5.8
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 10:31 Finish Time: 10:36	
Trial	Int. Count
1	9300
2	9294
3	9334
4	9178
5	9249
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
Mean:	9271.0
Expected S.D.:	96.3
Standard Dev.:	60.1
Variance:	3618
% CV:	0.65

Start Time: 11:50 Finish Time: 11:55	
Trial	Int. Count
1	9256
2	9117
3	9233
4	9137
5	9142
Mean:	9177.0
Expected S.D.:	95.8
Standard Dev.:	62.9
variance:	3950.5
% CV:	0.68

Start Time: 13:52 Finish Time: 13:57	
Trial	Int. Count
1	9353
2	9384
3	9173
4	9264
5	9330
Mean:	9300.8
Expected S.D.:	96.4
Standard Dev.:	83.9
Variance:	7046.7
% CV:	0.90

Start Time: 15:00 Finish Time: 15:05	
Trial	Int. Count
1	9364
2	9308
3	9231
4	9290
5	9362
Mean:	9311
Expected S.D.:	96.5
Standard Dev.:	55.4
Variance:	3065
% CV:	0.59

Figure G-1g. Daily Instrument QA/QC Check

Date: 6-Apr-01
Weather: cloudy/humid
Location: 150 E
250 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	8:50	11:50	13:20	15:15
HV:	754	751	751	751
WINDOW	out	out	out	out
THRESHOLD	99	99	99	99
BATTERY	5.8	5.7	5.7	5.7
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 8:50 Finish Time: 9:20	
Trial	Int. Count
1	3835
2	3851
3	3756
4	3756
5	3734
6	3769
7	3835
8	3801
9	3767
10	3771
11	3697
12	3796
13	3780
14	3783
15	3858
Mean:	3785.9
Expected S.D.:	61.5
Standard Dev.:	44.6
Variance:	1991
% CV:	1.18

Start Time: 11:50 Finish Time: 11:55	
Trial	Int. Count
1	3616
2	3698
3	3707
4	3729
5	3786
Mean:	3707.2
Expected S.D.:	60.9
Standard Dev.:	61.4
variance:	3771.7
% CV:	1.66

Start Time: 13:20 Finish Time: 13:25	
Trial	Int. Count
1	3657
2	3749
3	3773
4	3637
5	3682
Mean:	3699.6
Expected S.D.:	60.8
Standard Dev.:	58.9
Variance:	3467.8
% CV:	1.59

Start Time: 15:15 Finish Time: 15:20	
Trial	Int. Count
1	3673
2	3608
3	3654
4	3715
5	3604
Mean:	3650.8
Expected S.D.:	60.4
Standard Dev.:	46.5
Variance:	2161.7
% CV:	1.27

Figure G-1h. Daily Instrument QA/QC Check

Date: 6-Apr-01
Weather: cloudy/humid
Location: 150 E
250 N
Technician: Shaw

Probe: 44-20
Serial Number: PR173692
Meter: 2221
Serial Number: 169248
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:08	11:01	13:31	15:14
HV:	806	804	804	804
WINDOW	out	out	out	out
THRESHOLD	100	100	99	99
BATTERY	6.1	6	6	5.9
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 9:08 Finish Time: 9:22	
Trial	Int. Count
1	4162
2	4074
3	4104
4	4059
5	4082
6	4020
7	4123
8	4113
9	4046
10	4049
11	4056
12	3994
13	4102
14	3905
15	3943
Mean:	4055.5
Expected S.D.:	63.7
Standard Dev.:	68.3
Variance:	4661
% CV:	1.68

Start Time: 11:01 Finish Time: 11:06	
Trial	Int. Count
1	3997
2	3940
3	4055
4	4078
5	4283
Mean:	4070.6
Expected S.D.:	63.8
Standard Dev.:	130.3
Variance:	16971.3
% CV:	3.20

Start Time: 13:21 Finish Time: 13:26	
Trial	Int. Count
1	3916
2	3994
3	3871
4	4077
5	3949
Mean:	3961.4
Expected S.D.:	62.9
Standard Dev.:	78.8
Variance:	6203.3
% CV:	1.99

Start Time: 15:15 Finish Time: 15:20	
Trial	Int. Count
1	4107
2	3982
3	4090
4	3995
5	4149
Mean:	4064.6
Expected S.D.:	63.8
Standard Dev.:	72.9
Variance:	5308.3
% CV:	1.79

Figure G-1i. Daily Instrument QA/QC Check

Date: 6-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	8:50	11:50	13:20	15:15
HV:	754	751	751	751
WINDOW	out	out	out	out
THRESHOLD	99	99	99	99
BATTERY	5.8	5.7	5.7	5.7
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 9:20 Finish Time: 9:40	
Trial	Int. Count
1	9364
2	9495
3	9253
4	9443
5	9345
6	9519
7	9454
8	9543
9	9453
10	9370
11	9476
12	9361
13	9420
14	9453
15	9480
Mean:	9428.6
Expected S.D.:	97.1
Standard Dev.:	76.8
Variance:	5905
% CV:	0.82

Start Time: 12:00 Finish Time: 12:05	
Trial	Int. Count
1	9331
2	9261
3	9352
4	9371
5	9342
Mean:	9331.4
Expected S.D.:	96.6
Standard Dev.:	42.0
Variance:	1765.3
% CV:	0.45

Start Time: 13:25 Finish Time: 13:40	
Trial	Int. Count
1	9260
2	9069
3	9174
4	9047
5	9263
Mean:	9162.6
Expected S.D.:	95.7
Standard Dev.:	102.3
Variance:	10455.3
% CV:	1.12

Start Time: 15:20 Finish Time: 15:25	
Trial	Int. Count
1	9312
2	9194
3	9034
4	9280
5	9094
Mean:	9182.8
Expected S.D.:	95.8
Standard Dev.:	118.6
Variance:	14073.2
% CV:	1.29

Figure G-1j. Daily Instrument QA/QC Check

Date: 6-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Shaw

Probe: 44-20
Serial Number: PR173692
Meter: 2221
Serial Number: 169248
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:25	10:45	13:30	15:05
HV:	805	804	804	804
WINDOW	out	out	out	out
THRESHOLD	100	100	100	100
BATTERY	6.1	6	6	6
COUNT TIME	30 sec	30 sec	30 sec	30 sec

Start Time: 9:25 Finish Time: 9:45	
Trial	Int. Count
1	9681
2	9784
3	9699
4	9605
5	9595
6	9625
7	9771
8	9723
9	9911
10	9994
11	9958
12	9747
13	9717
14	9648
15	9735
Mean:	9746.2
Expected S.D.:	98.7
Standard Dev.:	122.6
Variance:	15042
% CV:	1.26

Start Time: 10:45 Finish Time: 10:50	
Trial	Int. Count
1	9789
2	9785
3	9693
4	9516
5	9621
Mean:	9680.8
Expected S.D.:	98.4
Standard Dev.:	115.6
Variance:	13362.2
% CV:	1.19

Start Time: 15:05 Finish Time: 15:10	
Trial	Int. Count
1	9990
2	9891
3	9846
4	9879
5	9805
Mean:	9882.2
Expected S.D.:	99.4
Standard Dev.:	68.9
Variance:	4744.7
% CV:	0.70

Start Time: 13:30 Finish Time: 13:35	
Trial	Int. Count
1	9832
2	9757
3	9671
4	9724
5	9747
Mean:	9746.2
Expected S.D.:	98.7
Standard Dev.:	58.4
Variance:	3406.7
% CV:	0.60

Figure G-1k. Daily Instrument QA/QC Check

Date: 10-Apr-01
Weather: cloudy/humid
Location: 150 E
250 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:30	11:50
HV:	752	752
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6.1	6.1
COUNT TIME	30 sec	30 sec

Start Time: 9:30 Finish Time: 9:50	
Trial	Int. Count
1	3919
2	3778
3	3826
4	3778
5	3774
6	3858
7	3726
8	3898
9	3774
10	3725
11	3797
12	3789
13	3739
14	3753
15	3858
Mean:	3799.5
Expected S.D.:	61.6
Standard Dev.:	60.1
Variance:	3618
% CV:	1.58

Start Time: 11:50 Finish Time: 11:55	
Trial	Int. Count
1	3650
2	3569
3	3586
4	3666
5	3583
Mean:	3610.8
Expected S.D.:	60.1
Standard Dev.:	43.9
Variance:	1929.7
% CV:	1.22

Figure G-1l. Daily Instrument QA/QC Check

Date: 10-Apr-01
Weather: cloudy/humid
Location: 150 E
250 N
Technician: Shaw

Probe: 44-20
Serial Number: PR173692
Meter: 2221
Serial Number: 169248
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:35	11:50
HV:	805	804
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6	6
COUNT TIME	30 sec	30 sec

Start Time: 9:35 Finish Time: 9:50	
Trial	Int. Count
1	4042
2	3937
3	4140
4	3900
5	3984
6	3983
7	4034
8	3966
9	4012
10	4040
11	4104
12	4130
13	3913
14	4163
15	4011
Mean:	4023.9
Expected S.D.:	63.4
Standard Dev.:	81.6
Variance:	6665
% CV:	2.03

Start Time: 11:50 Finish Time: 11:55	
Trial	Int. Count
1	3938
2	3833
3	3845
4	3942
5	3931
Mean:	3897.8
Expected S.D.:	62.4
Standard Dev.:	54.0
Variance:	2914.7
% CV:	1.39

Figure G-1m. Daily Instrument QA/QC Check

Date: 10-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:51	11:57
HV:	752	752
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6.1	6.1
COUNT TIME	30 sec	30 sec

Start Time: 8:50 Finish Time: 9:10	
Trial	Int. Count
1	9354
2	9434
3	9145
4	9458
5	9215
6	9259
7	9267
8	9391
9	9320
10	9133
11	9129
12	9287
13	9179
14	9307
15	9304
Mean:	9278.8
Expected S.D.:	96.3
Standard Dev.:	104.8
Variance:	10986
% CV:	1.13

Start Time: 11:50 Finish Time: 11:55	
Trial	Int. Count
1	9260
2	9187
3	9325
4	9126
5	9258
Mean:	9231.2
Expected S.D.:	96.1
Standard Dev.:	76.4
Variance:	5841.7
% CV:	0.83

Figure G-1n. Daily Instrument QA/QC Check

Date: 10-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Shaw

Probe: 44-20
Serial Number: PR173692
Meter: 2221
Serial Number: 169248
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:45	11:43
HV:	805	804
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6	6
COUNT TIME	30 sec	30 sec

Start Time: 9:45 Finish Time: 10:00	
Trial	Int. Count
1	9779
2	9694
3	9744
4	9798
5	9656
6	9656
7	9885
8	9932
9	9700
10	9670
11	9798
12	9682
13	9709
14	9630
15	9787
Mean:	9741.3
Expected S.D.:	98.7
Standard Dev.:	87.6
Variance:	7678
% CV:	0.90

Start Time: 11:43 Finish Time: 11:48	
Trial	Int. Count
1	9896
2	10089
3	9738
4	9811
5	9771
Mean:	9861.0
Expected S.D.:	99.3
Standard Dev.:	140.5
Variance:	19734.5
% CV:	1.42

Figure G-1o. Daily Instrument QA/QC Check

Date: 11-Apr-01
Weather: cloudy/windy
Location: 150 E
250 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	13:35	14:15
HV:	750	751
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6.1	6
COUNT TIME	30 sec	30 sec

Start Time: 13:35 Finish Time: 13:50	
Trial	Int. Count
1	3787
2	3791
3	3766
4	3739
5	3898
6	3897
7	3904
8	3901
9	3863
10	3835
11	3888
12	3822
13	3853
14	3849
15	3817
Mean:	3840.7
Expected S.D.:	62.0
Standard Dev.:	53.0
Variance:	2805
% CV:	1.38

Start Time: 11:30 Finish Time: 11:40	
Trial	Int. Count
1	3646
2	3846
3	3786
4	3686
5	3739
Mean:	3740.6
Expected S.D.:	61.2
Standard Dev.:	79.2
Variance:	6276
% CV:	2.12

Figure G-1p. Daily Instrument QA/QC Check

Date: 11-Apr-01
Weather: cloudy/humid
Location: 180 E
20 N
Technician: Yliniemi

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:51	11:57
HV:	751	750
WINDOW	out	out
THRESHOLD	99	99
BATTERY	6.1	6
COUNT TIME	30 sec	30 sec

Start Time: 13:35 Finish Time: 13:50	
Trial	Int. Count
1	9506
2	9500
3	9549
4	9555
5	9464
6	9676
7	9478
8	9495
9	9407
10	9510
11	9509
12	9479
13	9581
14	9401
15	9426
Mean:	9502.4
Expected S.D.:	97.5
Standard Dev.:	70.3
Variance:	4948
% CV:	0.74

Start Time: 14:15 Finish Time: 14:20	
Trial	Int. Count
1	9457
2	9341
3	9629
4	9456
5	9530
Mean:	9482.6
Expected S.D.:	97.4
Standard Dev.:	106.2
Variance:	11273.3
% CV:	1.12

Figure G-1q. Daily Instrument QA/QC Check

Date: 14-Nov-01
Weather: cloudy/windy
Location: 150 E
250 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:15	13:00
HV:	918	919
WINDOW	out	out
THRESHOLD	145	145
BATTERY	5.9	6
COUNT TIME	30 sec	30 sec

Start Time: 9:15 Finish Time: 9:30	
Trial	Int. Count
1	4124
2	4066
3	3959
4	4075
5	4088
6	4027
7	4209
8	4095
9	4215
10	3941
11	4197
12	4106
13	3984
14	4129
15	4147
16	4028
17	4179
18	4155
19	4193
20	4178
Mean:	4104.8
Expected S.D.:	64.1
Standard Dev.:	83.6
Variance:	6990
% CV:	2.04

Figure G-1r. Daily Instrument QA/QC Check

Date: 14-Nov-01
Weather: cloudy/windy
Location: 180 E
20 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:15	13:00
HV:	918	919
WINDOW	out	out
THRESHOLD	145	145
BATTERY	5.9	6
COUNT TIME	30 sec	30 sec

Start Time: 10:00 Finish Time: 10:10	
Trial	Int. Count
1	9799
2	9998
3	9941
4	9771
5	9772
Mean:	9856.2
Expected S.D.:	99.3
Standard Dev.:	106.0
Variance:	11230
% CV:	1.08

Start Time: 12:45 Finish Time: 13:00	
Trial	Int. Count
1	10214
2	10169
3	10348
4	10213
5	10232
6	10260
7	10423
8	10242
9	10533
Mean:	10292.7
Expected S.D.:	101.5
Standard Dev.:	118.8
Variance:	14119
% CV:	1.15

Figure G-1s. Daily Instrument QA/QC Check

Date: 16-Nov-01
Weather: cloudy/water saturated soil
Location: 150 E
250 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:20	11:30
HV:	920	920
WINDOW	out	out
THRESHOLD	145	145
BATTERY	6.1	6
COUNT TIME	30 sec	30 sec

Start Time: 9:20 Finish Time: 9:40	
Trial	Int. Count
1	3827
2	3822
3	3846
4	3954
5	3923
6	3949
7	3995
8	3924
9	3683
10	3904
11	3826
12	3919
13	3911
14	3871
15	3862
Mean:	3881.1
Expected S.D.:	62.3
Standard Dev.:	75.5
Variance:	5696
% CV:	1.94

Start Time: 11:30 Finish Time: 11:40	
Trial	Int. Count
1	3895
2	3876
3	3953
4	3779
5	3984
6	3886
7	3816
8	3823
9	3888
10	3866
11	3926
12	3755
13	4003
14	3981
15	3852
Mean:	3885.5
Expected S.D.:	62.3
Standard Dev.:	74.5
Variance:	5545
% CV:	1.92

Figure G-1t. Daily Instrument QA/QC Check

Date: 16-Nov-01
Weather: cloudy/water saturated soil
Location: 180 E
20 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:20	11:30
HV:	920	920
WINDOW	out	out
THRESHOLD	145	145
BATTERY	6.1	6
COUNT TIME	30 sec	30 sec

Start Time: 9:20 Finish Time: 9:40	
Trial	Int. Count
1	8799
2	8602
3	8754
4	8985
5	8804
Mean:	8788.8
Expected S.D.:	93.7
Standard Dev.:	136.9
Variance:	18734
% CV:	1.56

Start Time: 11:30 Finish Time: 11:40	
Trial	Int. Count
1	8767
2	8921
3	9045
4	9001
5	8893
Mean:	8925.4
Expected S.D.:	94.5
Standard Dev.:	107.4
Variance:	11545
% CV:	1.20

Figure G-1u. Daily Instrument QA/QC Check

Date: 20-Nov-01
Weather: cloudy/windy/cool
Location: 400 E
50 N
Technician: Murchison

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	9:20
HV:	921
WINDOW	out
THRESHOLD	145
BATTERY	6
COUNT TIME	30 sec

Start Time: 9:30 Finish Time: 9:50	
Trial	Int. Count
1	7132
2	6987
3	7051
4	7018
5	6989
6	6946
7	7023
8	7115
9	7007
10	6993
11	7033
12	7181
13	7242
14	7223
15	7021
Mean:	7064.1
Expected S.D.:	84.0
Standard Dev.:	92.0
Variance:	8459
% CV:	1.30

Figure G-1v. Daily Instrument QA/QC Check

Date: 20-Nov-01
Weather: cloudy/windy/cool
Location: 10 E
-45 N
Technician: Rademacher

Probe: 44-20
Serial Number: PR173698
Meter: 2221
Serial Number: 169215
Geometry: w/ Shield & Detector 10 cm from Ground

Time:	12:10
HV:	921
WINDOW	out
THRESHOLD	145
BATTERY	6
COUNT TIME	30 sec

Start Time: 12:10 Finish Time: 12:30	
Trial	Int. Count
1	8306
2	8402
3	8310
4	8288
5	8279
Mean:	8317.0
Expected S.D.:	91.2
Standard Dev.:	49.2
Variance:	2420
% CV:	0.59

Table G
Paired In-Situ 3 x 3 NaI(Tl) Measurements

Coordinates		Measurement 1				Measurement 2			
North	East	Probe	Date	Time	Counts	Probe	Date	Time	Counts
10	250	173698	11-Apr-01	11:40	4844	173692	6-Apr-01	13:45	4777
20	250	173698	11-Apr-01	11:40	7957	173692	6-Apr-01	13:45	7760
30	250	173698	11-Apr-01	11:40	6551	173692	6-Apr-01	13:45	6221
40	250	173698	11-Apr-01	11:40	6739	173692	6-Apr-01	13:45	6736
50	250	173698	11-Apr-01	11:40	7018	173692	6-Apr-01	13:45	6716
50	250	173698	11-Apr-01	11:40	7018	173692	10-Apr-01	10:38	7120
50	250	173692	10-Apr-01	10:38	7120	173692	6-Apr-01	13:45	6716
0	200	173698	6-Apr-01	13:45	7286	173698	16-Mar-01	10:25	7335
50	200	173698	6-Apr-01	13:45	4285	173698	16-Mar-01	10:25	4397
50	200	173698	6-Apr-01	13:45	4285	173698	6-Apr-01	14:12	4255
50	200	173698	6-Apr-01	14:12	4255	173698	16-Mar-01	10:25	4397
40	200	173698	6-Apr-01	13:45	5557	173698	16-Mar-01	10:25	5767
30	200	173698	6-Apr-01	13:45	7377	173698	16-Mar-01	10:25	7383
20	200	173698	6-Apr-01	13:45	8971	173698	16-Mar-01	10:25	8731
10	200	173698	6-Apr-01	13:45	4491	173698	16-Mar-01	10:25	5105
200	350	173692	6-Apr-01	13:42	6233	173698	10-Apr-01	11:15	5930
150	350	173692	6-Apr-01	13:42	6558	173698	10-Apr-01	11:15	6208
190	350	173692	6-Apr-01	13:42	6000	173698	10-Apr-01	11:15	5751
180	350	173692	6-Apr-01	13:42	5499	173698	10-Apr-01	11:15	5059
170	350	173692	6-Apr-01	13:42	6045	173698	10-Apr-01	11:15	5711
160	350	173692	6-Apr-01	13:42	6532	173698	10-Apr-01	11:15	6251
200	200	173692	10-Apr-01	10:00	5570	173698	20-Mar-01	13:20	5104
150	200	173692	10-Apr-01	10:00	6312	173698	20-Mar-01	13:20	5864
150	200	173692	10-Apr-01	10:00	6312	173698	6-Apr-01	14:48	6059
150	200	173698	6-Apr-01	14:48	6059	173698	20-Mar-01	13:20	5864
190	200	173692	10-Apr-01	10:00	5176	173698	20-Mar-01	13:20	4961
180	200	173692	10-Apr-01	10:00	5564	173698	20-Mar-01	13:20	5233
170	200	173692	10-Apr-01	10:00	5478	173698	20-Mar-01	13:20	5221
160	200	173692	10-Apr-01	10:00	5764	173698	20-Mar-01	13:20	5438
150	250	173692	10-Apr-01	10:00	6726	173698	10-Apr-01	14:48	6451
100	300	173698	10-Apr-01	10:55	7203	173692	10-Apr-01	10:45	7300
140	250	173698	6-Apr-01	14:48	6326	173692	10-Apr-01	10:45	6564
130	250	173698	6-Apr-01	14:48	5795	173692	10-Apr-01	10:45	6158
120	250	173698	6-Apr-01	14:48	6257	173692	10-Apr-01	10:45	6395
110	250	173698	6-Apr-01	14:48	6402	173692	10-Apr-01	10:45	6957
100	250	173698	6-Apr-01	14:48	6536	173692	10-Apr-01	10:45	7104
140	350	173698	10-Apr-01	10:55	6900	173692	6-Apr-01	14:10	7200
130	350	173698	10-Apr-01	10:55	7096	173692	6-Apr-01	14:10	7342
120	350	173698	10-Apr-01	10:55	8078	173692	6-Apr-01	14:10	8340

Table G
Paired In-Situ 3 x 3 NaI(Tl) Measurements (Continued)

Coordinates		Measurement 1				Measurement 2			
North	East	Probe	Date	Time	Counts	Probe	Date	Time	Counts
100	350	173698	10-Apr-01	10:55	6957	173692	6-Apr-01	14:10	7063
50	350	173698	10-Apr-01	10:00	4250	173692	6-Apr-01	14:46	4474
50	350	173698	10-Apr-01	10:00	4250	173698	10-Apr-01	10:30	4242
50	350	173698	10-Apr-01	10:30	4242	173692	6-Apr-01	14:46	4474
90	350	173698	10-Apr-01	10:30	6109	173692	6-Apr-01	14:46	6391
80	350	173698	10-Apr-01	10:30	5375	173692	6-Apr-01	14:46	5714
70	350	173698	10-Apr-01	10:30	5182	173692	6-Apr-01	14:46	5645
60	350	173698	10-Apr-01	10:30	4027	173692	6-Apr-01	14:46	4302
90	300	173698	10-Apr-01	10:30	7476	173692	10-Apr-01	10:38	7642
80	300	173698	10-Apr-01	10:30	7412	173692	10-Apr-01	10:38	7455
70	300	173698	10-Apr-01	10:30	7090	173692	10-Apr-01	10:38	7027
60	300	173698	10-Apr-01	10:30	6682	173692	10-Apr-01	10:38	7005
50	300	173698	10-Apr-01	10:30	7039	173692	10-Apr-01	10:38	7509
100	200	173698	20-Mar-01	13:58	4868	173698	16-Mar-01	12:45	4761
100	200	173698	20-Mar-01	13:58	4868	173698	6-Apr-01	14:12	4651
100	200	173698	6-Apr-01	14:12	4651	173698	16-Mar-01	12:45	4761
140	200	173698	20-Mar-01	13:58	5821	173698	6-Apr-01	14:48	5928
130	200	173698	20-Mar-01	13:58	4858	173698	6-Apr-01	14:48	4979
120	200	173698	20-Mar-01	13:58	4884	173698	6-Apr-01	14:48	4772
110	200	173698	20-Mar-01	13:58	4536	173698	6-Apr-01	14:48	4393
90	200	173698	16-Mar-01	12:45	4455	173698	6-Apr-01	14:12	4317
80	200	173698	16-Mar-01	12:45	5010	173698	6-Apr-01	14:12	4922
70	200	173698	16-Mar-01	12:45	4378	173698	6-Apr-01	14:12	4548
60	200	173698	16-Mar-01	12:45	4920	173698	6-Apr-01	14:12	4852
50	150	173698	13-Mar-01	14:40	4540	173698	16-Mar-01	10:25	4621
50	150	173698	13-Mar-01	14:40	4540	173698	20-Mar-01	10:45	4514
50	150	173698	20-Mar-01	10:45	4514	173698	16-Mar-01	10:25	4621
40	150	173698	13-Mar-01	14:40	4882	173698	16-Mar-01	10:25	4738
30	150	173698	13-Mar-01	14:40	4460	173698	16-Mar-01	10:25	4390
20	150	173698	13-Mar-01	14:40	4408	173698	16-Mar-01	10:25	4206
10	150	173698	13-Mar-01	14:40	4116	173698	16-Mar-01	10:25	3907
0	150	173698	13-Mar-01	14:40	3860	173698	16-Mar-01	10:25	4066
0	150	173698	13-Mar-01	14:40	3860	173692	6-Apr-01	10:25	4020
0	150	173692	6-Apr-01	10:25	4020	173698	16-Mar-01	10:25	4066
90	150	173698	16-Mar-01	12:45	3956	173698	20-Mar-01	10:45	4011
100	150	173698	20-Mar-01	13:58	4883	173698	20-Mar-01	10:45	4842
100	150	173698	6-Apr-01	10:25	4700	173698	20-Mar-01	13:58	4883
100	150	173698	6-Apr-01	10:25	4700	173698	20-Mar-01	10:45	4842
100	150	173698	16-Mar-01	12:45	4788	173698	6-Apr-01	10:25	4700
100	150	173698	16-Mar-01	12:45	4788	173698	20-Mar-01	10:45	4842

Table G
Paired In-Situ 3 x 3 NaI(Tl) Measurements (Continued)

Coordinates		Measurement 1				Measurement 2			
North	East	Probe	Date	Time	Counts	Probe	Date	Time	Counts
100	150	173698	16-Mar-01	12:45	4788	173698	20-Mar-01	13:58	4883
80	150	173698	16-Mar-01	12:45	4206	173698	20-Mar-01	10:45	4144
70	150	173698	16-Mar-01	12:45	4212	173698	20-Mar-01	10:45	4351
60	150	173698	16-Mar-01	12:45	4468	173698	20-Mar-01	10:45	4693
150	150	173698	20-Mar-01	13:58	4011	173698	6-Apr-01	10:25	3931
140	150	173698	20-Mar-01	13:58	4413	173698	6-Apr-01	10:25	4130
130	150	173698	20-Mar-01	13:58	4217	173698	6-Apr-01	10:25	4107
120	150	173698	20-Mar-01	13:58	4347	173698	6-Apr-01	10:25	4295
110	150	173698	20-Mar-01	13:58	4281	173698	6-Apr-01	10:25	4133
200	150	173698	20-Mar-01	13:20	3786	173698	6-Apr-01	10:50	3497
190	150	173698	20-Mar-01	13:20	3786	173698	6-Apr-01	10:50	3567
180	150	173698	20-Mar-01	13:20	3871	173698	6-Apr-01	10:50	3686
170	150	173698	20-Mar-01	13:20	3865	173698	6-Apr-01	10:50	3859
160	150	173698	20-Mar-01	13:20	4027	173698	6-Apr-01	10:50	3651
0	100	173692	20-Mar-01	10:05	7630	173698	13-Mar-01	14:10	7496
50	100	173692	16-Mar-01	14:05	4641	173698	13-Mar-01	14:10	4837
100	100	173698	16-Mar-01	14:05	4894	173698	20-Mar-01	10:45	4868
100	100	173698	16-Mar-01	14:05	4894	173698	6-Apr-01	10:25	4642
100	100	173698	6-Apr-01	10:25	4642	173698	20-Mar-01	10:45	4868
90	100	173698	16-Mar-01	14:05	5241	173698	20-Mar-01	10:45	5344
80	100	173698	16-Mar-01	14:05	5036	173698	20-Mar-01	10:45	5227
70	100	173698	16-Mar-01	14:05	4783	173698	20-Mar-01	10:45	4831
60	100	173698	16-Mar-01	14:05	4390	173698	20-Mar-01	10:45	4619
150	100	173698	6-Apr-01	10:25	6313	173698	3-Apr-01	10:45	6507
140	100	173698	6-Apr-01	10:25	5880	173698	3-Apr-01	10:45	6193
130	100	173698	6-Apr-01	10:25	5583	173698	3-Apr-01	10:45	5686
120	100	173698	6-Apr-01	10:25	5220	173698	3-Apr-01	10:45	5507
110	100	173698	6-Apr-01	10:25	5684	173698	3-Apr-01	10:45	5740
90	250	173698	6-Apr-01	14:12	6631	173692	10-Apr-01	10:38	6992
80	250	173698	6-Apr-01	14:12	5990	173692	10-Apr-01	10:38	6204
70	250	173698	6-Apr-01	14:12	6878	173692	10-Apr-01	10:38	7148
60	250	173698	6-Apr-01	14:12	6825	173692	10-Apr-01	10:38	7285
0	50	173692	6-Apr-01	9:36	8262	173698	13-Mar-01	14:10	8322
50	50	173698	16-Mar-01	13:39	7362	173698	13-Mar-01	13:30	7629
100	50	173698	3-Apr-01	10:45	6788	173698	16-Mar-01	14:05	6702
150	50	173698	3-Apr-01	10:45	6805	173698	6-Apr-01	9:38	6841
160	50	173698	3-Apr-01	13:20	7121	173698	6-Apr-01	9:38	6787
170	50	173698	3-Apr-01	13:20	7253	173698	6-Apr-01	9:38	7047
180	50	173698	3-Apr-01	13:20	7473	173698	6-Apr-01	9:38	7584
190	50	173698	3-Apr-01	13:20	6516	173698	6-Apr-01	9:38	6049

Table G
Paired In-Situ 3 x 3 NaI(Tl) Measurements (Continued)

Coordinates		Measurement 1				Measurement 2			
North	East	Probe	Date	Time	Counts	Probe	Date	Time	Counts
200	50	173698	3-Apr-01	13:20	6668	173698	6-Apr-01	9:38	6601
0	0	173698	13-Mar-01	13:30	7508	173692	6-Apr-01	9:36	8036
50	0	173698	13-Mar-01	13:30	6022	173698	16-Mar-01	13:30	5836
100	0	173698	3-Apr-01	10:45	6359	173698	16-Mar-01	13:30	6142
100	400	173692	6-Apr-01	14:46	5609	173692	6-Apr-01	14:10	5757
50	400	173698	10-Apr-01	10:00	4471	173692	6-Apr-01	14:46	4815
50	390	173698	10-Apr-01	10:00	6248	173692	6-Apr-01	14:46	6446
50	380	173698	10-Apr-01	10:00	6202	173692	6-Apr-01	14:46	6490
50	370	173698	10-Apr-01	10:00	5636	173692	6-Apr-01	14:46	6175
50	360	173698	10-Apr-01	10:00	4710	173692	6-Apr-01	14:46	5107
150	240	173698	6-Apr-01	14:48	6525	173692	10-Apr-01	10:00	6989
150	230	173698	6-Apr-01	14:48	6323	173692	10-Apr-01	10:00	6532
150	220	173698	6-Apr-01	14:48	6361	173692	10-Apr-01	10:00	6639
150	210	173698	6-Apr-01	14:48	5942	173692	10-Apr-01	10:00	6270
100	190	173698	20-Mar-01	13:58	5900	173698	16-Mar-01	12:45	5843
100	180	173698	20-Mar-01	13:58	7652	173698	16-Mar-01	12:45	7641
100	170	173698	20-Mar-01	13:58	5902	173698	16-Mar-01	12:45	5749
100	160	173698	20-Mar-01	13:58	7253	173698	16-Mar-01	12:45	7200
100	140	173698	6-Apr-01	10:25	4917	173698	20-Mar-01	10:45	4861
100	130	173698	6-Apr-01	10:25	4228	173698	20-Mar-01	10:45	4324
100	120	173698	6-Apr-01	10:25	4465	173698	20-Mar-01	10:45	4649
100	110	173698	6-Apr-01	10:25	4330	173698	20-Mar-01	10:45	4519
50	140	173698	13-Mar-01	14:40	8382	173698	20-Mar-01	10:45	8267
50	130	173698	13-Mar-01	14:40	4682	173698	20-Mar-01	10:45	4623
50	120	173698	13-Mar-01	14:40	5043	173698	20-Mar-01	10:45	4986
50	110	173698	13-Mar-01	14:40	4485	173698	20-Mar-01	10:45	4493
0	140	173698	13-Mar-01	14:40	4051	173692	6-Apr-01	10:25	4502
0	130	173698	13-Mar-01	14:40	5532	173692	6-Apr-01	10:25	6501
0	120	173698	13-Mar-01	14:40	8050	173692	6-Apr-01	10:25	8397
0	110	173698	13-Mar-01	14:40	7345	173692	6-Apr-01	10:25	7623
150	90	173698	6-Apr-01	9:38	6297	173698	3-Apr-01	10:45	6607
150	80	173698	6-Apr-01	9:38	6079	173698	3-Apr-01	10:45	6469
150	70	173698	6-Apr-01	9:38	6641	173698	3-Apr-01	10:45	6902
150	60	173698	6-Apr-01	9:38	6871	173698	3-Apr-01	10:45	7218
100	90	173698	16-Mar-01	14:05	5370	173698	3-Apr-01	14:05	5781
100	80	173698	16-Mar-01	14:05	5794	173698	3-Apr-01	14:05	6097
100	70	173698	16-Mar-01	14:05	5833	173698	3-Apr-01	14:05	6154
100	60	173698	16-Mar-01	14:05	6404	173698	3-Apr-01	14:05	6503
50	90	173698	16-Mar-01	14:05	5068	173698	13-Mar-01	14:10	5305
50	80	173698	16-Mar-01	14:05	5521	173698	13-Mar-01	14:10	5749

Table G
Paired In-Situ 3 x 3 NaI(Tl) Measurements (Continued)

Coordinates		Measurement 1				Measurement 2			
North	East	Probe	Date	Time	Counts	Probe	Date	Time	Counts
50	70	173698	16-Mar-01	14:05	5141	173698	13-Mar-01	14:10	5366
50	60	173698	16-Mar-01	14:05	7303	173698	13-Mar-01	14:10	7594
0	90	173692	6-Apr-01	10:05	8234	173698	13-Mar-01	14:10	7966
0	80	173692	6-Apr-01	10:05	7946	173698	13-Mar-01	14:10	7649
0	70	173692	6-Apr-01	10:05	7993	173698	13-Mar-01	14:10	7937
0	60	173692	6-Apr-01	10:05	7757	173698	13-Mar-01	14:10	7589
100	40	173698	16-Mar-01	13:30	6608	173698	3-Apr-01	10:45	6856
100	30	173698	16-Mar-01	13:30	6486	173698	3-Apr-01	10:45	6736
100	20	173698	16-Mar-01	13:30	4454	173698	3-Apr-01	10:45	4513
100	10	173698	16-Mar-01	13:30	4524	173698	3-Apr-01	10:45	4883
50	40	173698	16-Mar-01	13:30	7169	173698	13-Mar-01	13:30	7109
50	30	173698	16-Mar-01	13:30	6388	173698	13-Mar-01	13:30	6495
50	20	173698	16-Mar-01	13:30	4026	173698	13-Mar-01	13:30	4005
50	10	173698	16-Mar-01	13:30	4502	173698	13-Mar-01	13:30	4958
0	40	173692	6-Apr-01	9:36	8144	173698	13-Mar-01	13:30	7847
0	30	173692	6-Apr-01	9:36	8110	173698	13-Mar-01	13:30	7567
0	20	173692	6-Apr-01	9:36	4939	173698	13-Mar-01	13:30	4952
0	10	173692	6-Apr-01	9:36	6421	173698	13-Mar-01	13:30	6020

Denotes location where more than two measurements were collected.

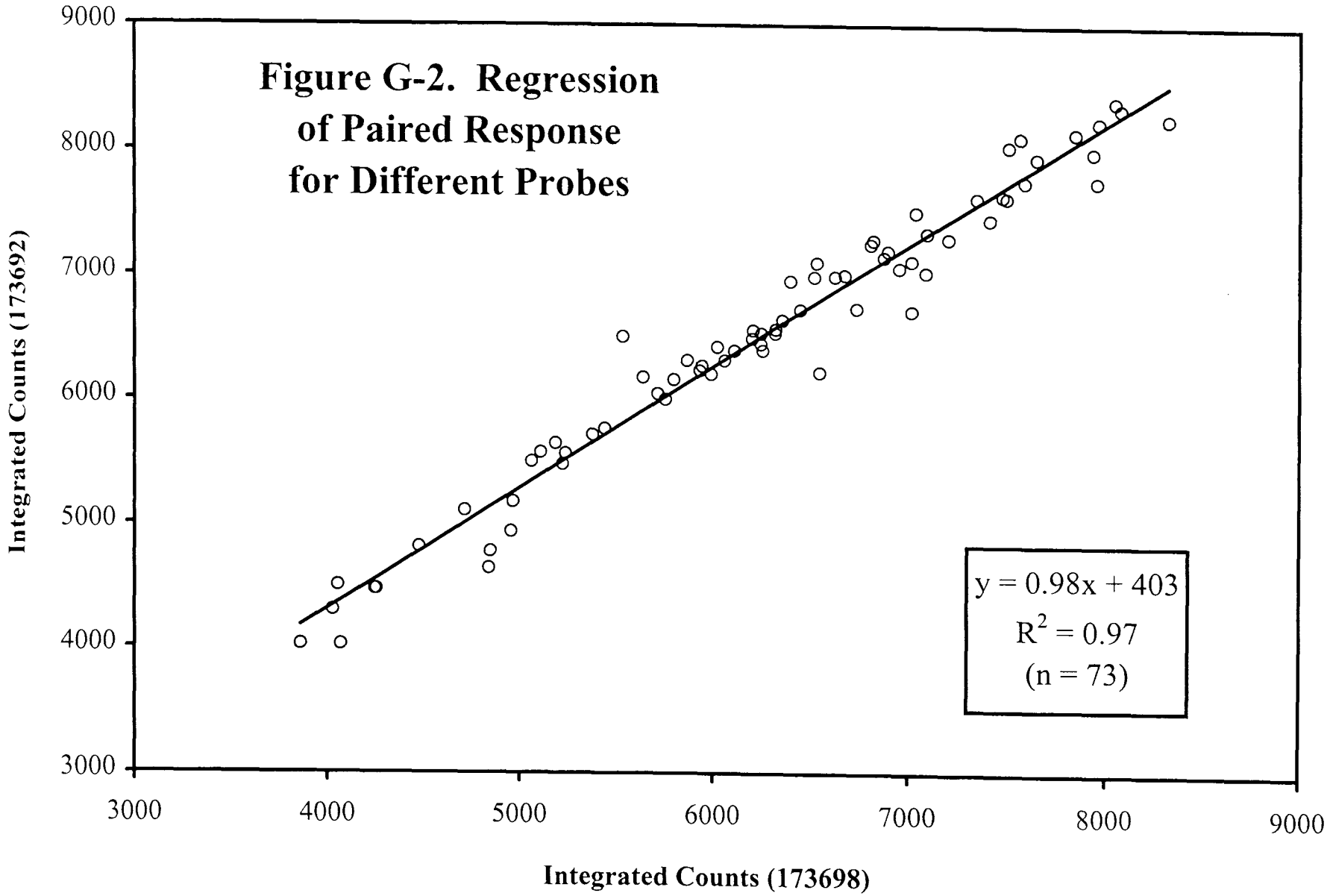
Figure G-2. Regression of Paired Response for Different Probes
Integrated Counts (173692)
Integrated Counts (173698)
9000
8000
7000
6000
5000
4000
3000
3000
4000
5000
6000
7000
8000
9000
y = 0.98x + 403
R2 = 0.97
(n = 73)

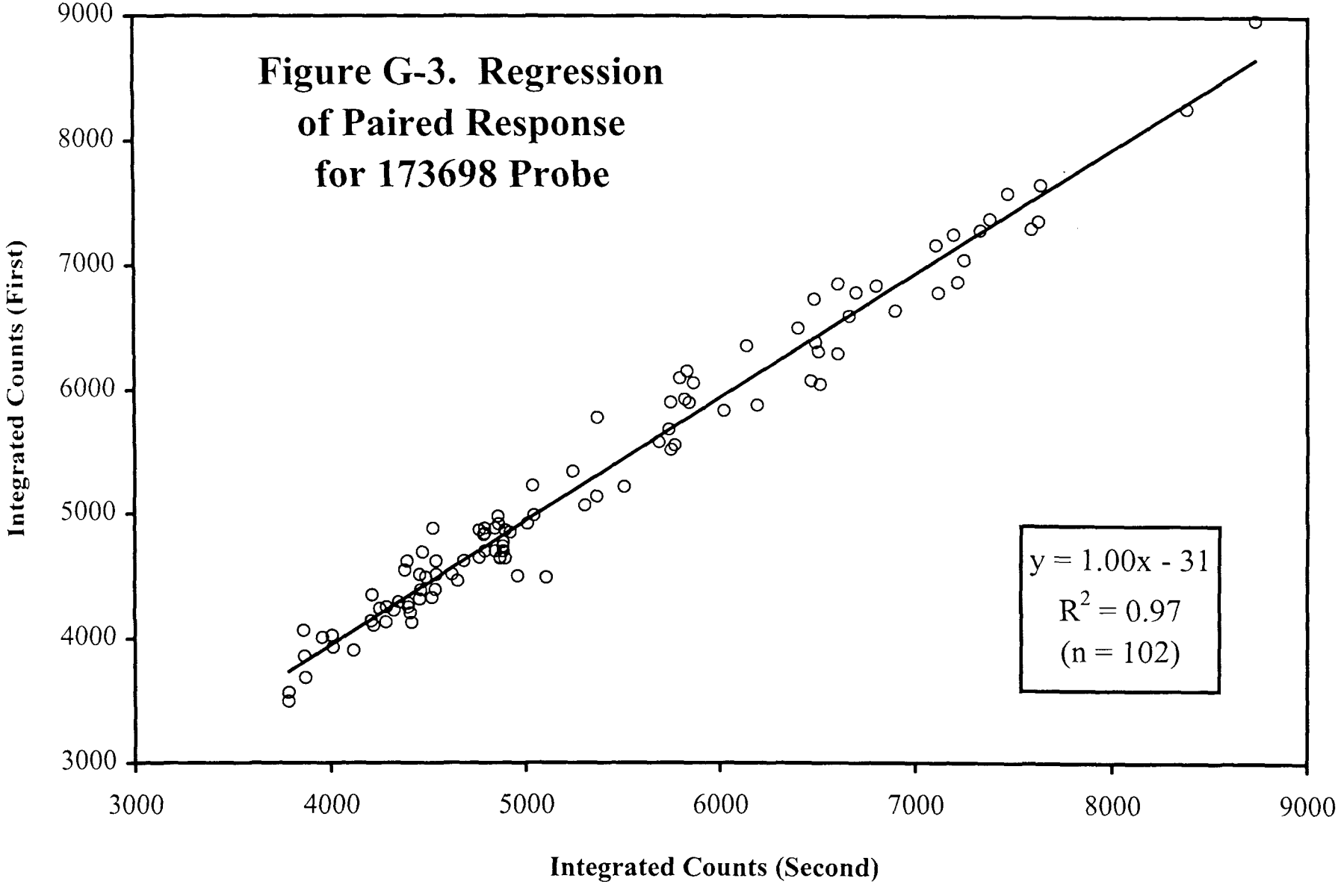
Figure G-3. Regression of Paired Response for 173698 Probe
Integrated Counts (First)
Integrated Counts (Second)
9000
8000
7000
6000
5000
4000
3000
3000
4000
5000
6000
7000
8000
9000
y = 1.00x - 31
R2 = 0.97
(n = 102)

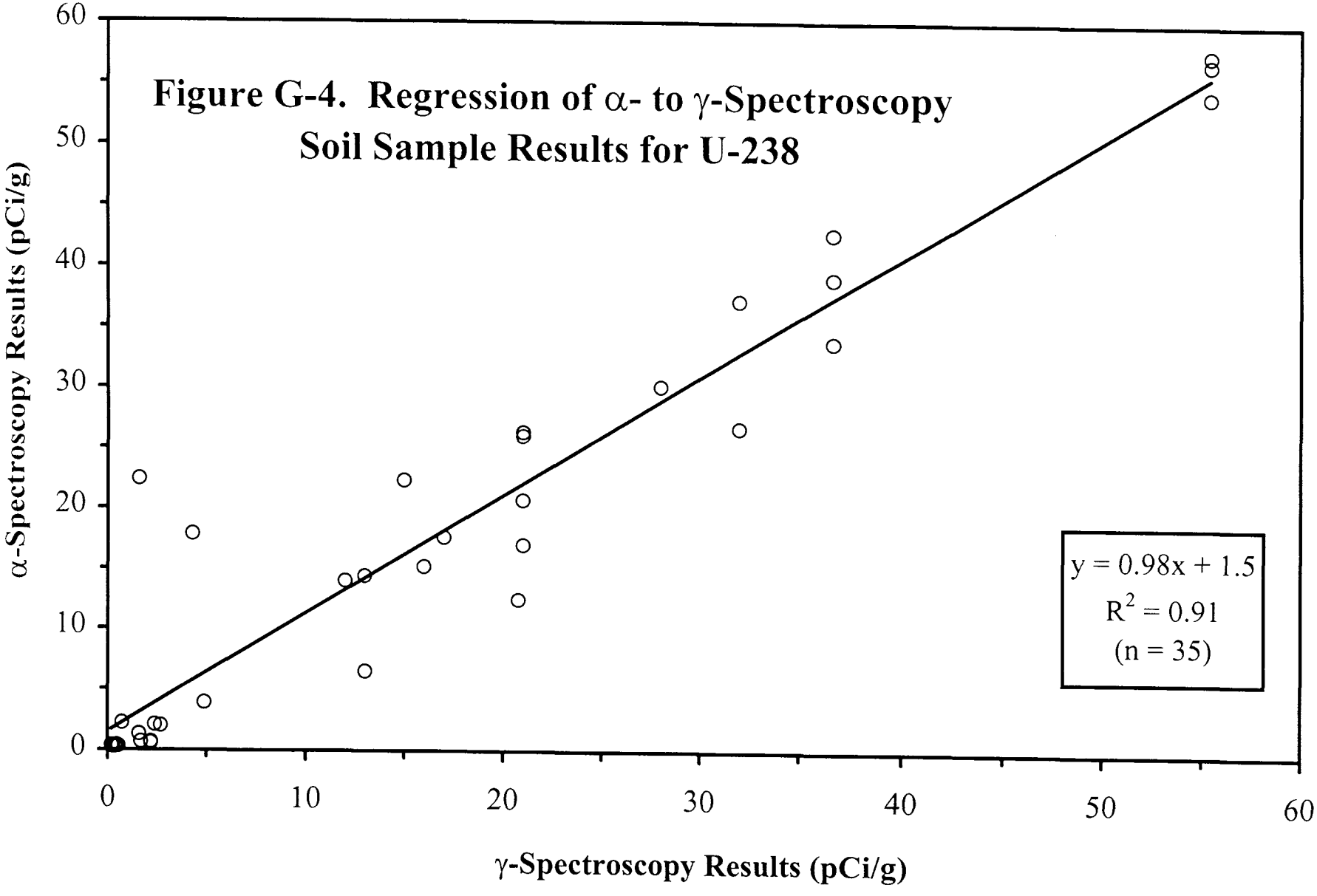
Figure G-4. Regression of α- to γ-Spectroscopy Soil Sample Results for U-238
α-Spectroscopy Results (pCi/g)
γ-Spectroscopy Results (pCi/g)
0
10
20
30
40
50
60
y = 0.98x + 1.5
R2 = 0.91
(n = 35)

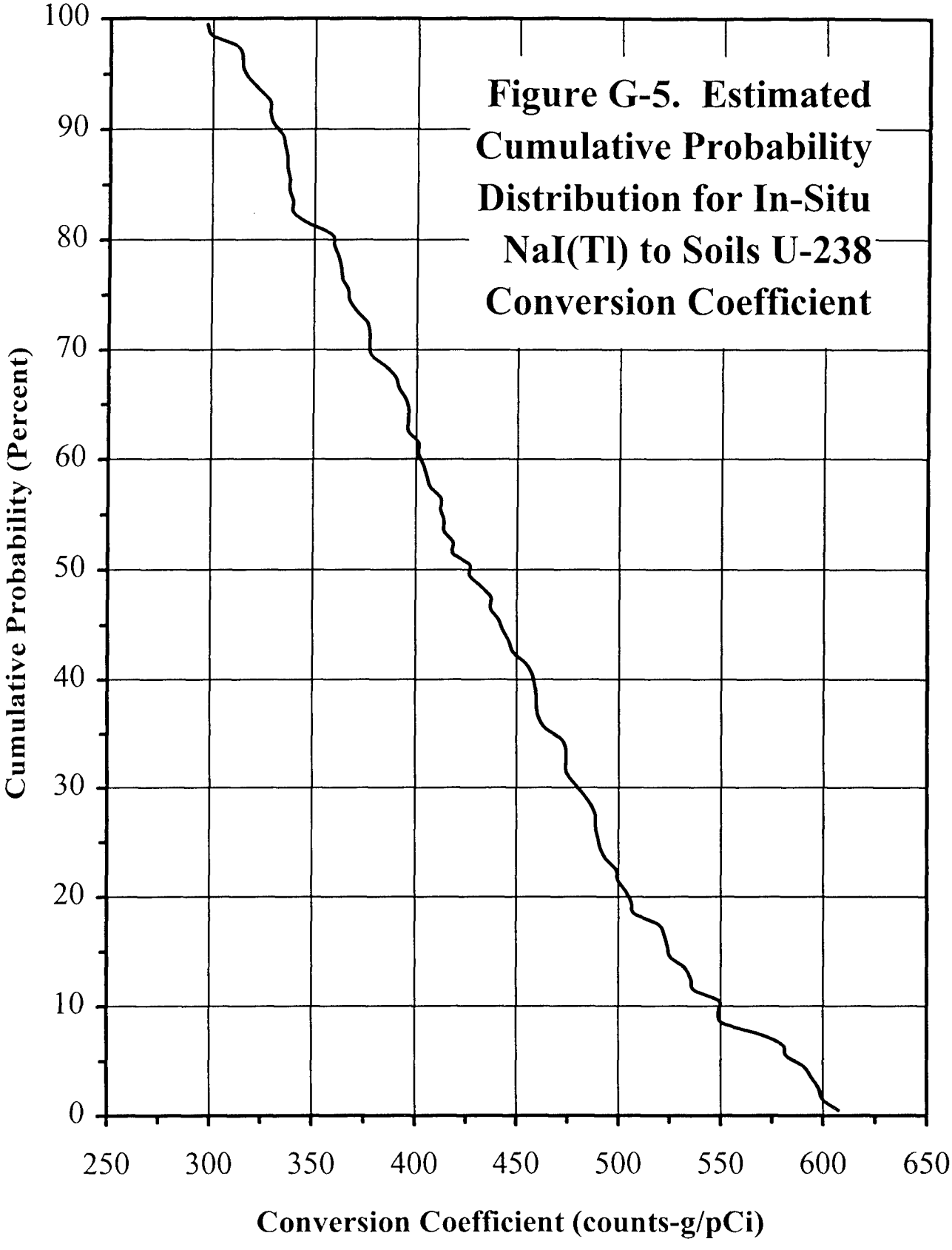
Figure G-5. Estimated Cumulative Probability Distribution for In-Situ NaI(Tl) to Soils U-238 Conversion Coefficient
Cumulative Probability (Percent)
100
90
80
70
60
50
40
30
20
10
0
250
300
350
400
450
500
550
600
650
Conversion Coefficient (counts-g/pCi)

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH (AFMC)
BROOKS CITY-BASE TEXAS

30 April 2007

MEMORANDUM FOR DTIC-OCQ
ATTN: LARRY DOWNING
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FROM: AFIOH/DOBP (STINFO)
2513 Kennedy Circle
Brooks City-Base TX 78235-5116

SUBJECT: Changing the Distribution Statement on a Technical Report

This letter documents the requirement for DTIC to change the distribution statement from "C" to "A" (Approved for public release; distribution is unlimited.) and delete the Export Control Warning on the following technical report: AD Number ADB279086, IERA-SD-BR-SR-2002-0001, Interim Radiological Scoping and Characterization Survey Report, 1963 Igloo 572 Accident (Former Medina Base), Lackland AFB TX.

If additional information or a corrected cover page and SF Form 298 are required please let me know. You can reach me at DSN 240-6019 or my e-mail address is sherry.mathews@brooks.af.mil.

Thank you for your assistance in making this change.

Sherry Y. Mathews

SHERRY Y. MATHEWS
AFIOH STINFO Officer