Sypran

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

MCHB-DC-OIP (40)

28 MAR 1997

MEMORANDUM FOR Commander, U.S. Army Environmental Center, ATTN: SFIM-AEC-ETD (Mr. Hutchins), Aberdeen Proving Ground, MD 21010-5401

SUBJECT: Industrial Radiation Study No. 27-MH-0987-R1-96, Iron Mountain & Rattlesnake Gulch Sites, Fort McClellan, AL, 27 February - 15 March 1995

1. Copies of subject report with Executive Summary are enclosed. Findings and a recommendation for release of the Iron Mountain and Rattlesnake Gulch areas for unrestricted use are provided.

2. A copy of the Executive Summary only is being furnished to the U.S. Army Medical Command, ATTN: MCHO-CL-W.

FOR THE COMMANDER:

Encl

Harris E. Edge
HARRIS EDGE
Program Manager
Industrial Health Physics

CF:
CDR, MEDCOM, ATTN: MCHO-CL-W (EXSUM Only)

Readiness thru Health

USACHPPM

U.S. Army Center for Health Promotion and Preventive Medicine

INDUSTRIAL RADIATION STUDY NO. 27-MH-0987-R1-96
IRON MOUNTAIN AND RATTLESNAKE GULCH SITES
FORT MCCLELLAN, ALABAMA
27 FEBRUARY - 15 MARCH 1995

Distribution limited to U.S. Government agencies only; protection of privileged information evaluating another command; Mar 97. Requests for this document must be referred to Commander, U.S. Army Environmental Center, ATTN: SFIM-AEC-ETD, Aberdeen Proving Ground, MD 21010-5401.

Readiness Thru Health

DESTRUCTION NOTICE - Destroy by any method that will prevent disclosure of contents or reconstruction of the document

U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) lineage can be traced back over a half century to the Army Industrial Hygiene Laboratory which was established at the beginning of World War II under the direct jurisdiction of The Army Surgeon General. It was originally located at the Johns Hopkins School of Hygiene and Public Health with a staff of three and ~~an~~ annual budget not to exceed three thousand dollars. Its mission was to conduct occupational health surveys of Army-operated industrial plants, arsenals, and depots. These surveys were aimed at identifying and eliminating occupational health hazards within the Department of Defense's (DOD) industrial production base and proved to be extremely beneficial to the Nation's war effort.

Most recently, the organization has been nationally and internationally known as the U.S. Army Environmental Hygiene Agency (AEHA) and is located on the Edgewood area of Aberdeen Proving Ground, Maryland. Its mission had been expanded to support the worldwide preventive medicine programs of the Army, DOD and other Federal agencies through consultations, supportive services, investigations and training.

On 1 August 1994, the organization was officially redesignated the U.S. Army Center for Health Promotion and Preventive Medicine and is affectionately referred to as the CHPPM. As always, our mission focus is centered upon the Army Imperatives to that we are optimizing soldier effectiveness by minimizing health risk. The CHPPM's mission is to provide worldwide scientific expertise and services in the areas of:

- Clinical and field preventive medicine
- Environmental and occupational health
- Health promotion and wellness
- Epidemiology and disease surveillance
- Related laboratory services

The Center's quest has always been one of customer satisfaction, technical excellence and continuous quality improvement. Our vision is to be a world-class center of excellence for enhancing military readiness by integrating health promotion and preventive medicine into America's Army. To achieve that end, CHPPM holds everfast to its core values which are steeped in our rich heritage:

- Integrity is our foundation
- Excellence is our standard
- Customer satisfaction is our focus
- Our people are our most valuable resource
- Continuous quality improvement is our pathway

Once again, the organization stands on the threshold of even greater challenges and responsibilities. The CHPPM structure has been reengineered to include General Officer leadership in order to support the Army of the future. The professional disciplines represented at the Center have been expanded to include a wide array of medical, scientific, engineering, and administrative support personnel.

As the CHPPM moves into the next century, we are an organization fiercely proud of our history, yet equally excited about the future. The Center is destined to continue its development as a world-class organization with expanded preventive health care services provided to the Army, DOD, other Federal agencies, the Nation, and the world community.

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

EXECUTIVE SUMMARY
DRAFT INDUSTRIAL RADIATION STUDY NO. 27-MH-0987-R1-96
IRON MOUNTAIN AND RATTLESNAKE GULCH SITES
FORT MCCLELLAN, ALABAMA
27 FEBRUARY - 15 MARCH 1995

I. PURPOSE. This study was conducted to determine the presence and extent of radiological health hazards associated with the Fort McClellan, AL, former low-level radiological material burial ground sites of Iron Mountain and Rattlesnake Gulch. Also, to determine whether residual radioactivity levels observed meet the Nuclear Regulatory Commission regulations and guidelines for release to unrestricted use of the sites.

II. CONCLUSION. A review of the survey results indicate there were no radiological health hazards identified at the Iron Mountain and Rattlesnake Gulch sites. The survey results also indicate that the radioactivity levels measured are typical of the naturally occurring background levels.

III. RECOMMENDATION. Recommend the Iron Mountain and Rattlesnake Gulch sites of Fort McClellan, AL, be released for unrestricted use.

CONTENTS

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

MCHB-DC-OIP

28 MAR 1997

INDUSTRIAL RADIATION STUDY NO. 27-MH-0987-R1-96
IRON MOUNTAIN AND RATTLESNAKE GULCH SITES
FORT MCCLELLAN, ALABAMA
27 FEBRUARY - 15 MARCH 1995

I. REFERENCES. See Appendix A for a list of references.

II. AUTHORITY. Memorandum, USAEC, SFIM-AEC-TSS, 27 December 1993, subject: Request for Technical Services.

III. PURPOSE.

A. To assess radiological health hazards associated with potential contamination at Iron Mountain and Rattlesnake Gulch, Fort McClellan, Alabama. These areas were former low-level radioactive material burial grounds.

B. To determine if any residual radioactivity is in compliance with the Nuclear Regulatory Commission (NRC) guidance for unrestricted use.

IV. GENERAL.

A. An entrance interview and periodic briefings, to include discussions of the findings and recommendations, were held with Mr. John W. May, Department of the Army Civilian (DAC), Fort McClellan Radiation Protection Officer (RPO) and Staff Sergeant (SSG) Kenneth S. Baugh, Fort McClellan Alternate Radiation Protection Officer.

B. The study was performed under the direction of Ms. Frances Szrom, DAC, Health Physicist, Industrial Health Physics Program, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Survey team members are listed in Appendix D. Appendix E contains a list of instrumentation used for this study.

C. The survey team would like to acknowledge Mr. John W. May and SSG Kenneth S. Baugh for their exceptional assistance rendered during the study. Their commitment to project completion was demonstrated in their approach to coordinating and providing the survey team with the required support in the areas of transportation, radiation and Explosive Ordnance safety personnel. Mr. Mays' and SSG Baughs' personal involvement extended well beyond normal duty hours. Without the level of support provided by these professionals, the study could not have been accomplished.

V. SITE BACKGROUND. A synopsis of the historical information pertaining to the Iron Mountain and Rattlesnake Gulch areas of Fort McClellan, AL, is contained in the Iron Mountain and Rattlesnake Gulch Environmental Sampling Plan. This Sampling Plan is contained in Appendix C. A brief overview is provided below:

A. The Iron Mountain and Rattlesnake Gulch sites were utilized as radioactive material burial sites by the U.S. Army Chemical Corps School during the 1950's. The burial grounds were reported to have been closed in 1959. The radioactive wastes were reported to have been recovered and reburied at the radioactive material burial site located at Rideout Field, Pelham Range, Area 24C, Fort McClellan, Alabama.

B. In 1971, after hearing persistent rumors about Rattlesnake Gulch, the Chief, Health Physics Division of the U.S. Army Chemical Center and School (USACMLCS) began an investigation to locate the Rattlesnake Gulch burial ground area. On 18 February 1971, a fenced area about 180 feet long and 80 feet wide was located on a ridge line of Iron Mountain, approximately 300 meters (m) Southeast of Summerall Gate Road. Radioactive material and radioactive soil contamination found at this site was packaged in 55-gallon drums and disposed of at an Atomic Energy Commission (AEC) licensed disposal facility (References 8-13).

C. For this study, the Iron Mountain site was located by the Fort McClellan RPO, based on the map coordinates in Reference 5. The referenced map coordinates were located with a military Global Positioning System (GPS) Receiver. An area close to the referenced coordinates had evidence of past burial activity and vegetation of recent growth when compared to the surrounding environs. This area is located approximately 200m down the northern slope of the Iron Mountain peak. Grid coordinates and additional site location information for the Iron Mountain site is contained in the Sampling Plan at Appendix C.

D. For this study, the Rattlesnake Gulch site was located by two members of the 1971 Health Physics Division of the USACMLCS. The first member identified was Mr. Barthel F. Truffa while he was performing Base Realignment and Closure contract work for the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) during December 1994 - January 1995. The Project Officer (Ms. Frances Szrom) for this study had noted historical documents with references to a SSG Truffa (references 5, 8, and 11). Inquiries made by the Project Officer established Mr. Truffa as the individual referenced as SSG Truffa in the historical documents. The second member, Mr. George W. Pryor, was identified by Mr. Truffa as another individual referred to in reference 8. Mr. Truffa contacted Mr. Pryor and both volunteered to assist Ms. Szrom in locating the Rattlesnake Gulch site. The area identified had evidence of past trenching activity and vegetation of recent growth when compared to the surrounding environs. This area is located approximately 600 meters down the North north-western ridge line from the Iron Mountain peak and 350m Southeast of the Summerall Gate Road. Grid coordinates and additional site location information for the Rattlesnake Gulch site is contained in the Sampling Plan at Appendix C.

E. Although the AEC licenses (BML 1-2861-1, BML 1-2861-2, and SNM 344) held by the USACMLCS were terminated in 1973, a formal close-out survey was not performed as required by the current Title 10, Code of Federal Regulations, Parts 30, and 70. Since no record of a formal close-out survey could be located, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), requested the U.S. Army Environmental Hygiene Agency (USAEHA) investigate these areas (references 1 and 3). The USATHAMA has been redesignated as the U.S. Army Environmental Center (USAEC) and USAEHA has been redesignated as the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). This report details the current (27 February - 15 March 1995) investigations at the Iron Mountain and Rattlesnake Gulch sites. The background area and survey unit locations for each site are noted on a portion of the Fort McClellan topographic map at Figure 1.

VI. RADIATION SURVEYS AND RESULTS. The Iron Mountain and Rattlesnake Gulch Environmental Sampling Plan is attached as Appendix C. The Sampling Plan contains the basis for this study and explains the various surveys that constitute this study. The results of the various surveys are discussed below.

A. Instrumentation Surveys - Iron Mountain Site.

1. Gamma Background Measurements and Results.

a. Gamma scanning surveys were performed with an Eberline ASP-1 survey meter and an Eberline PG-2 Scintillation Probe assembly. The PG-2 probe is a ruggedized thin-crystal NaI(Tl) detector 2 inches in diameter by 2 milli-meters thick. The thin-crystal gives this probe characteristics which enhance operator ability to locate buried radioactive materials. First, its thin-crystal gives the probe directional discrimination without the use of heavy lead collimators. Second, its high efficiency for low-energy gamma photons and x-rays enable it to detect the bremsstrahlung x-rays from moderate to high energy beta emitters as well as compton scattered gamma photons and x-rays.

(1) Iron Mountain background measurements were taken approximately 175m uphill (south) from the Iron Mountain site. Two 30 feet by 30 feet grids were established in the background area. The location of the Iron Mountain Background Area is identified in Figure 1.

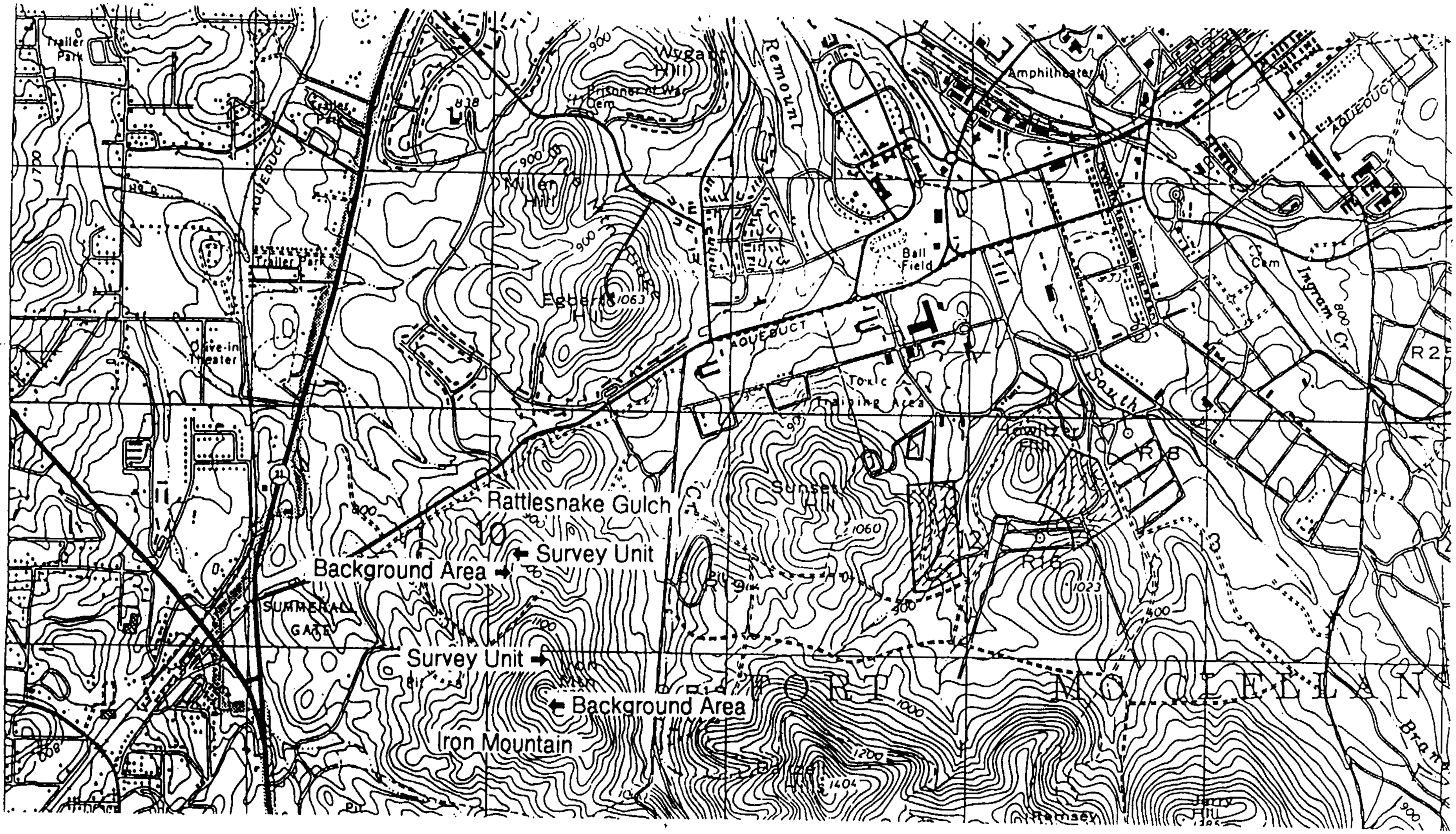
(2) The PG-2 probe was attached to the end of a rod and passed back and forth within 6 inches of the surface while the operator moved forward at a rate of approximately 0.5 meters (m) per second. Gamma scanning background rates ranged from 1000 counts per minute (cpm) to 1600 cpm. The average gamma scanning background rate was 1200 cpm.

(3) Quality control (QC) limits were established for the ASP-1 survey meter (SN: 2871) and PG-2 probe assembly. Operational checks were performed by exposing the detector to a cesium-137 (Cs-137) calibration standard prior to each day's operation and periodically during the day.

b. Gamma exposure rate monitoring was performed with an Eberline Model ESP-2 survey meter and an Eberline Model SPA-3 Scintillation Probe Assembly. The probe contains a 2 inch by 2 inch sodium iodide [NaI(Tl)] crystal, 2-inch 10 stage photo-multiplier tube socket with a dynode resistor string, and magnetic shield. The sensitivity is approximately 1,200,000 CPM per 1 milliroentgen per hour (mR/hr) with a Cs-137 source and about 500,000 CPM/mR/hr with cobalt-60 (Co-60).

(1) Iron Mountain background measurements were taken approximately 175m uphill (south) from the Iron Mountain site. Two 30 feet by 30 feet grids were established in the background area. The location of the Iron Mountain Background Area is identified in Figure 1.

Figure 1. Iron Mountain and Rattlesnake Gulch Site Locations



(2) Gamma exposure rate background levels ranged from 4.98 to 5.76 microroentgen per hour (μR/hr); the average background gamma exposure rate was 5.26 μR/hr. Measurements were taken 1m from the ground surface with the exposure rate averaged electronically (scaler average rate mode) for a period of 15 seconds. All Iron Mountain Background Area gamma exposure rate measurements are presented in Table F-1.

(2) The QC limits were established for the ESP-2 survey meter [Serial Number (SN): 355] and SPA-3 probe assembly (SN: D0468). Operational checks were performed by exposing the detector to a Cs-137 calibration standard prior to each day's operation and periodically during the day.

c. After removal of the soil core samples (see paragraph VI.B), gamma scalar counts were performed at various depths down the hole. This "down-hole" logging survey was performed with a Ludlum Model 2350 Data Logger and a Ludlum Model 44-62 Scintillation Probe Assembly. The Ludlum Model 44-62 probe is a 0.5 inch diameter by 1 inch thick NaI(Tl) detector.

(1) Iron Mountain background soil core samples were collected approximately 175m uphill (south) from the Iron Mountain site. Two 30 feet by 30 feet grids were established in the background area. In each grid, soil core samples were collected from five locations, in the standard "Z" pattern. Background soil core samples were collected to a maximum depth of 12 feet. The location of the Iron Mountain Background Area is identified in Figure 1.

(2) The Ludlum 44-62 detector was attached to the Ludlum Data Logger with an 18 foot cable. Tape was placed on the cable in 1 foot increments. Where possible, scalar measurements were made at the 1, 3, 5, 7, 9, and 11 foot marks. Several of the holes collapsed before the planned readings were taken. The Iron Mountain Background Logging results are listed in Table F-5. The average rate varied from 1611 cpm at the 1 foot depth to 2769 cpm at the 11 foot depth. Complete descriptive statistics for the Iron Mountain Background Area down-hole logging survey are contained in Table G-1.

(3) The QC limits were established for the Ludlum 2350 Data Logger (SN: 117562) and Ludlum Model 44-62 probe assembly (SN: PR121362). Operational checks were performed by exposing

the detector to a Cs-137 calibration standard prior to each day's operation and periodically during the day.

2. Survey Measurements and Results.

a. Instrumentation Surveys. The Iron Mountain Survey Unit consisted of fifteen 30 foot by 30 foot grids (3 grids by 5 grids). A diagram of the grid layout and survey/sampling scheme is included in Appendix C. The location of the Iron Mountain Site is identified in Figure 1.

b. Summary of Gamma Scanning Survey Results. A walk over gamma scanning survey of the Iron Mountain site was performed. This survey was performed to identify areas in the survey unit with elevated readings, and potential contamination, when compared to the background survey unit. This survey was performed as described in paragraph VI.A.1.a(2). No areas over twice background were noted. These results show no evidence of potential contamination.

c. Summary of Gamma Exposure Rate Survey Results. All gamma radiation exposure rate measurements at the Iron Mountain site varied between 1.20 μR/hr below and 1.49 μR/hr above the determined background. See Table F-1, for all gamma instrumentation survey results for the Iron Mountain site.

d. Summary of Down-Hole Logging Survey Results. The results of the down-hole logging for the Iron Mountain site are listed in Table F-5. The results show no evidence of buried radioactive sources in the subsurface environs.

B. Soil Sample Surveys and Results - Iron Mountain Site.

1. Sample Collection and Identification. The Iron Mountain Survey Unit grids (15 total) were established as previously described (paragraph VI.A.2.a). Sets of core soil samples were collected from each sample point (5 sample points per grid) noted in the Sampling Plan (Appendix C).

a. The sampling equipment (Geoprobe Large Bore Soil Sampling System) used collects a 1.125 inch diameter soil bore up to 2 feet in length. Therefore, core soil samples were planned to be collected in 2-foot sections at various depths below the surface. At each sample point, a set of three core soil samples were planned to be collected at depths of 2 feet to 4 feet, 6 feet to 8 feet and 10 to 12 feet below the surface.

b. Soil mounds, from 1 foot to 2 feet above the surrounding surface, were present in portions of the Iron Mountain Survey Unit. If a mound was present at a sampling point, then a core soil sample was collected from the top of the mound to the surrounding surface. These soil core samples were 1 or 2 feet in length.

c. In some cases, the sampling equipment was not able to collect samples to the 12 foot depth. This was due to natural obstructions, such as rock formations, in the subsurface environment. As a result, not all core soil samples were collected at the planned depths. Some core soil samples were collected at the 9 to 11 foot depth, while others could only be collected at the 2 to 4 foot depth or the 6 to 8 foot depth.

d. Each soil core sample collected was labeled with a unique identifier. This identifier indicates the survey unit location [Iron Mountain (IM), Iron Mountain Background (IM BKG), Rattlesnake Gulch (RG), Rattlesnake Gulch Background (RG BKG)], the grid sampling point (A1-1, A1-2, ..., E3-4, E3-5), and the depth (+2/0, +1/0, -2/4, -6/8, -9/11, or -10/12) at which the soil core sample was collected. For example, sample identifier, IM BKG A1-5-2/4, was collected in the Iron Mountain Background area, grid location A1-5, at a depth of 2 to 4 feet below the surface. Sample identifier IM B2-1+1/0, was collected in the Iron Mountain area, grid location B2-1, from a mound that was 1 foot above the surrounding surface.

2. Background Core Soil Sample Results.

a. Laboratory analyses were performed on each background soil core sample. Twenty-eight background core soil samples were collected and analyzed. Ten-2/4 foot, nine-6/8 foot, and nine-10/12 foot background core soil samples were analyzed. The background core soil samples were analyzed for gross alpha, gross beta-gamma activities and for gamma emitting isotopes. Duplicate samples were prepared by the laboratory as required by their quality assurance standing operating procedure (SOP). All background core soil sample results, including duplicate analyses, are included in Table F-3. The following narrative results are summarized in Table 1.

b. The gross alpha activities ranged from a low of 16 picocuries per gram (pCi/g) of soil to a high of 36 pCi/g; the average background gross alpha activity was 25.9 pCi/g.

c. The gross beta-gamma activities ranged from a low of 12 pCi/g to a high of 56 pCi/g; the average background gross beta-gamma activity was 29.3 pCi/g.

d. The gamma spectral analyses indicated the presence of potassium-40 (K-40), with activities that ranged from 5 to 54 pCi/g and averaged 21.9 pCi/g; actinium-228 (Ac-228) with activities that ranged from 1.9 to 3.6 pCi/g and averaged 2.4 pCi/g; bismuth-214 (Bi-214) with activities that ranged from 0.8 to 1.9 pCi/g and averaged 1.2 pCi/g; and lead-214 (Pb-214) with activities that ranged from 0.9 to 2.0 pCi/g and averaged 1.3 pCi/g.

Table 1. Iron Mountain Background Area Soil Analysis Summary

Analyte	**Low (pCi/g)**	**High (pCi/g)**	**Average (pCi/g)**
Gross Alpha	16	36	25.9
Gross Beta-Gamma	12	56	29.3
K-40	5	54	21.9
Ac-228	1.9	3.6	2.4
Bi-214	0.8	1.9	1.2
Pb-214	0.9	2.0	1.3

3. Iron Mountain Survey Unit Core Soil Sample Results.

a. Forty-five core soil sample sets were collected from the Iron Mountain Survey Unit. Laboratory analysis of the Iron Mountain core soil samples were performed by grid at like sample depths [e.g., all of the 2/4 foot depths (up to 5 samples) from the same grid were composited by the laboratory for analysis]. A total of one+2/0 foot, two+1/0 foot, fifteen-2/4 foot, fifteen-6/8 foot, fourteen-9/11 foot, and one-10/12 foot samples were analyzed from the Iron Mountain Survey Unit. The composited Iron Mountain Survey Unit soil samples were analyzed for gross alpha, gross beta-gamma activities and for gamma emitting isotopes. Duplicate samples were prepared by the laboratory as required by their quality assurance SOP. All Iron Mountain Survey Unit soil sample results, including duplicate analyses, are included in Table F-3. Iron Mountain Background and Survey Unit comparisons and statistical analyses are presented in Appendix G, Tables G-1 through G-3 and Figures G-1 and G-2. The following narrative results are summarized in Table 2.

b. The gross alpha activity representative is 5 pCi/g. The gross alpha activities ranged from a low of 9.1 pCi/g of soil to a high of 37 pCi/g; the average gross alpha activity was 20.3 pCi/g.

c. The gross beta-gamma activity representative minimum detectable activity (MDA) is 4 pCi/g. The gross beta-gamma activities ranged from a low of 6.8 pCi/g to a high of 42 pCi/g; the average gross beta-gamma activity was 17.7 pCi/g.

d. The gamma spectral analyses indicated the presence of K-40, with activities that ranged from 0.1 to 36 pCi/g and averaged 10.8 pCi/g; Ac-228 with activities that ranged from 1.0 to 3.0 pCi/g and averaged 2.0 pCi/g; Bi-214 with activities that ranged from 0.5 to 2.0 pCi/g and averaged 1.1 pCi/g; and Pb-214 with activities that ranged from 0.6 to 2.1 pCi/g and averaged 1.2 pCi/g.

Table 2. Iron Mountain Survey Unit Soil Analysis Summary

Analyte	**Low (pCi/g)**	**High (pCi/g)**	**Average (pCi/g)**
Gross Alpha	9.1	37	20.3
Gross Beta-Gamma	6.8	42	17.7
K-40	0.1	36	10.8
Ac-228	1.0	3.0	2.0
Bi-214	0.5	2.0	1.1
Pb-214	0.6	2.1	1.2

C. Data Interpretation - Iron Mountain Site. The ultimate goal of the decommissioning process is to assure that future uses of any licensed facility will not result in individuals being exposed to unacceptable levels of radiation and/or radioactive materials. This is normally accomplished by ensuring any residual radioactive material is below the release guidelines established by regulatory agencies such as the NRC. These guideline values refer to radiation and radioactivity above normal background levels.

1. Gamma Exposure Rate. The release criteria for direct radiation levels is 5 microRoentgen per hour (μR/hr) above the established background exposure rate. No exposure rates greater

background (paragraph VI.A.2.c) were noted. Therefore, the Iron Mountain Survey Unit meets the release criteria for direct radiation levels.

2. Cobalt-60. The release criteria for Co-60 activity in soil is 8 pCi/g. The Co-60 is not naturally occurring and is not expected to be present in background samples. The Co-60 laboratory analyses representative MDA is 0.2 pCi/g. No Co-60 activity above the MDA was detected in samples from the Iron Mountain Background Area or Survey Unit. Therefore, the Iron Mountain Survey Unit meets the release criteria for Co-60 activity in soil.

3. Cesium-137. The release criteria for Cs-137 activity in soil is 15 pCi/g.

a. The Cs-137 activity is not naturally occurring, but unlike Co-60 activity, it is found worldwide in surface soil samples. The source of the surface soil Cs-137 activity is fallout from atmospheric nuclear weapons testing and nuclear reactor accidents. The Cs-137 activity is usually found in the top several centimeters of soil with concentrations ranging from less than 0.1 pCi/g to several pCi/g depending on the soil type and porosity.

b. The Cs-137 laboratory analyses representative MDA is 0.1 pCi/g. Three samples analyzed had activities greater than the representative MDA. These samples are Sample No. IM B2-1+1/0 (1.4 pCi/g), Sample No. IM C2-1+1/0 (0.2 pCi/g), and Sample No. IM A2-5+2/0 (0.8 pCi/g). These samples are cores from the mounds present in the survey unit and the activities are consistent with those expected from fallout.

c. The Iron Mountain survey unit meets the release criteria for Cs-137 activity in soil.

4. Gross Alpha and Gross Beta-Gamma Measurements. Gross alpha activity and gross beta-gamma activity screening measurements were also performed on the composited soil samples. There are no release criteria for either gross alpha activity or gross beta-gamma activity measurements. However, if the Iron Mountain Background Area samples and the Iron Mountain Survey Unit samples can be shown to be similar radiologically, it may be inferred that they are from the same population. Basic descriptive statistics, including mean, median, standard deviation, variance, etc., were calculated for the gross alpha activity and gross beta-gamma activity measurements from the Iron Mountain Background Area

activity measurements from the Iron Mountain Background Area samples and the Iron Mountain Survey Unit samples. A statistical summary is presented in Table G-2. Complete descriptive statistics are presented in Table G-3.

a. Gross Alpha Activity Statistical Analyses.

(1) Review of the Iron Mountain Survey Unit gross alpha activity descriptive statistics indicate a symmetrical or normal distribution since the values of the mean and median (20.3 pCi/g and 20.5 pCi/g) are comparable. Likewise, the Iron Mountain Background Area gross alpha activity mean and median (25.9 pCi/g and 24.5 pCi/g) are indicative of a normal distribution. The standard deviations of the Iron Mountain Survey Unit and Iron Mountain Background Area (5.3 pCi/g and 5.4 pCi/g) are comparable.

(2) Hypotheses tests can be used to compare the differences between two population means. Since the Iron Mountain Survey Unit and Iron Mountain Background Area gross alpha activity populations appear to be normally distributed, a parametric hypothesis test, such as the pooled t-test for two population means can be used. Assumptions required to use the pooled t-test include: independent samples, normal populations, and equal population standard deviations. The significance level, α, chosen for the hypothesis test was 0.05.

(3) The gross alpha activity null hypothesis (H_0) was: The Iron Mountain Survey Unit and the Iron Mountain Background Area population means are equal (i.e., $\mu_1 = \mu_2$ and the hypothesized mean difference is zero). The alternative hypotheses was: The population means are not equal. Results of the pooled t-test indicate a t-statistic (4.45) that was greater than the two-tail t critical value (±1.99) for this test. Therefore, the H_0 was rejected.

(4) Further evaluation revealed the gross alpha activity mean from the Iron Mountain Background Area (25.9 pCi/g) was actually greater than the Iron Mountain Survey Unit (20.3 pCi/g) mean. This is due to the higher levels of naturally occurring thorium and thorium progeny and naturally occurring uranium and uranium progeny in the background area. Actinium-228 (Ac-228) is a radionuclide in the natural thorium series and Bismuth-214 (Bi-214) is a radionuclide in the natural uranium series. The background area Ac-228 activity was approximately 0.5 pCi/g greater than the survey unit Ac-228 activity. The background area Bi-214 activity

was approximately 0.1 pCi/g greater than the survey unit Bi-214 activity. These activity differences are indicative of the natural thorium and natural uranium decay chain activity differences. This would account for a 3.4 pCi/g difference in the gross alpha activity measurement.

(5) Therefore, the H_0 was restated as the population means are within 3.4 pCi/g of being equal (the hypothesized mean difference is 3.4 pCi/g). The alternative hypothesis was: The population means are not within 3.4 pCi/g. The t-statistic (1.77) is greater than the lower tail critical value (-1.99) and less than the upper tail critical value (1.99) for this test. Therefore, the H_0 is accepted and the gross alpha activity of the Iron Mountain Survey Unit is radiologically similar to the Iron Mountain Background Area.

(6) Results of the Iron Mountain gross alpha activity hypotheses tests are presented in Appendix G, Table G-4.

b. Gross Beta-Gamma Activity Statistical Analyses.

(1) Review of the Iron Mountain Survey Unit gross beta-gamma activity descriptive statistics indicate an asymmetrical distribution since the values of the mean and median (17.7 pCi/g and 13 pCi/g) are not comparable. Evaluation of the background area and survey unit statistical data show a significant difference between the mean and median values for the gross beta-gamma measurements in the Iron Mountain survey unit. Residual contamination is usually asymmetrically distributed at a site. Since strontium-90 (Sr-90) was a possible concern and decays by beta emission, further investigation was performed.

(2) Samples exhibiting high gross beta-gamma measurements were also high in K-40 content. Potassium is a naturally occurring radioisotope which decays by beta-gamma emission. When the K-40 activity contribution was subtracted from its respective gross beta-gamma activity measurement, the mean and median (6.9 pCi/g and 7 pCi/g) values were in good agreement and indicative of a symmetric or normal distribution. Therefore, the initial asymmetric distribution is attributed to differences in the activity of naturally occurring K-40 in the samples.

(3) Pooled t-tests were performed on the Iron Mountain Survey Unit and Iron Mountain Background Area gross beta-gamma activity and K-40 activity. As expected, the gross beta-gamma

activity and K-40 activity results failed the t-test. However, when the results of the gross beta-gamma activity measurements minus their respective K-40 activity was tested, the H_0, the population means are equal, was accepted. Therefore, the gross beta-gamma activity minus the naturally occurring K-40 activity of the Iron mountain Survey Unit is radiologically similar to the Iron Mountain Background Area.

(4) Results of the gross beta-gamma, K-40, and gross beta-gamma minus K-40 hypotheses tests are presented in Appendix G, Tables G-5 through G-7.

D. Instrumentation Surveys - Rattlesnake Gulch Site.

1. Gamma Background Measurements and Results.

a. Gamma scanning surveys were performed as in paragraph VI.A.1.a.

(1) Rattlesnake Gulch background measurements were taken approximately 40m uphill (SSE) from the Rattlesnake Gulch site. Two 30 feet by 30 feet grids were established in the background area. The location of the Rattlesnake Gulch Background Area is identified in Figure 1.

(2) Gamma scanning background rates ranged from 800 cpm to 1200 cpm. The average gamma scanning background rate was 1000 cpm.

(3) The QC limits were established for the ASP-1 survey meter (SN: 2871) and PG-2 probe assembly. Operational checks were performed by exposing the detector to a Cs-137 calibration standard prior to each day's operation and periodically during the day.

b. Gamma exposure rate monitoring was performed as described in paragraph VI.A.1.b.

(1) Gamma background measurements were taken approximately 40m uphill (SSE) from the Rattlesnake Gulch site. Two 30 feet by 30 feet grids were established in the background area. The location of the Rattlesnake Gulch Background Area is identified in Figure 1.

(2) Gamma exposure rate background levels ranged from 4.20 to 4.55 μR/hr; the average background gamma exposure rate was 4.39 μR/hr. Measurements were taken 1m from the ground surface with the

(scaler average rate mode) for a period of 15 seconds. All Rattlesnake Gulch Background Area gamma exposure rate measurements are presented in Table F-2.

(3) The QC limits were established for the ESP-2 survey meter and SPA-3 probe combination (SN: 355/D0468). Operational checks were performed by exposing the detector to a Cs-137 calibration standard prior to each day's operation and periodically during the day.

c. After removal of the soil core samples (see paragraph VI.E) gamma scalar counts were performed at various depths down the hole. This "down-hole" logging was performed as described in paragraph VI.A.1.c.

(1) Rattlesnake Gulch background soil core samples were collected approximately 40m uphill (SSE) from the Rattlesnake Gulch site. Two 30 feet by 30 feet grids were established in the background area. In each grid, soil core samples were collected from five locations, in the standard "Z" pattern. Background soil core samples were collected to a maximum depth of 12 feet. The location of the Rattlesnake Gulch Background Area is identified in Figure 1.

2. Survey Measurements and Results.

a. Instrumentation Survey. The Rattlesnake Gulch Survey Unit consisted of 15 30 foot by 30 foot grids (3 grids by 5 grids). A diagram of the grid layout and survey/sampling scheme are included in Appendix C. The location of the Rattlesnake Gulch Site is identified in Figure 1.

b. Summary of Gamma Scanning Survey Results. A walk over gamma scanning survey of the Rattlesnake Gulch Survey Unit was performed. This survey was performed to identify areas in the survey unit with elevated readings, and potential contamination, when compared to the background survey area. No areas over twice background were noted. These results show no evidence of potential contamination.

c. Summary of Gamma Exposure Rate Survey Results. All gamma radiation exposure rate measurements at the Rattlesnake Gulch site varied between 1.50 μR/hr below and 0.24 μR/hr below the average background exposure rate. See Table F-2 for all gamma instrumentation survey results for the Rattlesnake Gulch site.

d. Summary of Down-Hole Logging Results. The Ludlum Model 44-62 0.5 inch diameter NaI(Tl) detector was apparently damaged when the equipment was moved from the Iron Mountain site to the Rattlesnake Gulch site. The measurements recorded at this site were inconsistent and erratic before the probe was finally lost in a hole collapse. Although none of the measurements recorded were higher than anticipated, many of them were below what is expected of normal background measurements. The lower than expected values are symptomatic of a loss of optical coupling between the photomultiplier and the NaI(Tl) crystal. Therefore, the results of these measurements are judged to be unreliable and unusable for this study.

E. Soil Sample Surveys and Results - Rattlesnake Gulch Site.

1. Sample Collection and Identification. The Rattlesnake Gulch Survey Unit grids (15 total) were established as previously described (paragraph VI.D.2.a). Sets of core soil samples were collected from each sample point (5 sample points per grid) noted in the Sampling Plan (Appendix C).

a. The sampling equipment (Geoprobe Large Bore Soil Sampling System) used collects a 1.125 inch diameter soil bore up to 2 feet in length. Therefore, core soil samples were planned to be collected in 2-foot sections at various depths below the surface. At each sample point, a set of three core soil samples were planned to be collected at depths of 2 to 4 feet, 6 to 8 feet and 10 to 12 feet below the surface.

b. A soil mound, 2 feet above the surface, was present at one sample point in the Rattlesnake Gulch Survey Unit. A core soil sample was collected from the top of the mound to the surrounding surface.

c. In some cases, the sampling equipment was not able to collect samples to the 12-foot depth. This was due to natural obstructions, such as rock formations, in the subsurface environment. As a result, not all core soil samples were collected at the planned depths.

d. Each soil core sample collected was labeled with a unique identifier, as previously described in paragraph VI.B.1.d.

2. Background Core Soil Sample Results.

a. Laboratory analyses were performed on each background soil core sample. Seventeen background core soil samples were collected and analyzed. Ten-2/4 foot, four-6/8 foot, one-9/11 foot, and two-10/12 foot background samples were analyzed. The background core soil samples were analyzed for gross alpha, gross beta-gamma activities and for gamma emitting isotopes. Duplicate samples were prepared by the laboratory as required by their QA SOP. All background core soil sample results, including duplicate analyses, are included in Table F-4. The following narrative results are summarized in Table 3.

b. The gross alpha activities ranged from a low of 7.9 pCi/g of soil to a high of 35 pCi/g; the average background for gross alpha activity was 19.5 pCi/g.

c. The gross beta-gamma activities ranged from a low of 4.1 pCi/g to a high of 20 pCi/g; the average background for gross beta-gamma activity was 10.8 pCi/g.

d. The gamma spectral analyses indicated the presence of K-40, with activities that ranged from 0.6 to 6.0 pCi/g and averaged 3.0 pCi/g; Ac-228 with activities that ranged from 0.8 to 3.0 pCi/g and averaged 1.9 pCi/g; Bi-214 with activities that ranged from 0.5 to 1.7 pCi/g and averaged 1.0 pCi/g; and Pb-214 with activities that ranged from 0.5 to 2.2 pCi/g and averaged 1.2 pCi/g.

Table 3. Rattlesnake Gulch Background Area Soil Analysis Summary

Analyte	**Low (pCi/g)**	**High (pCi/g)**	**Average (pCi/g)**
Gross Alpha	7.9	35	19.5
Gross Beta-Gamma	4.1	20	10.8
K-40	0.6	6.0	3.0
Ac-228	0.8	3.0	1.9
Bi-214	0.5	1.7	1.0
Pb-214	0.5	2.2	1.2

3. Rattlesnake Gulch Survey Unit Core Soil Sample Results.

a. Forty-five core soil sample sets were collected from the Rattlesnake Gulch Survey Unit. Laboratory analysis of the Rattlesnake Gulch core soil samples were performed by grid at like sample depths [e.g., all of the 2-4 foot depths (up to 5 samples) from the same grid were composited by the laboratory for analysis]. A total of one+2/0 foot, fifteen-2/4 foot, fifteen-6/8 foot, and twelve-10/12 foot samples were analyzed from the Rattlesnake Gulch Survey Unit. The composited Rattlesnake Gulch soil samples were analyzed for gross alpha, gross beta-gamma activities and for gamma emitting isotopes. Duplicate analyses were performed by the laboratory as required by their QA SOP. All Rattlesnake Gulch Survey Unit soil sample results, including duplicate analyses, are included in Table F-4. Rattlesnake Gulch Background and Survey Unit comparisons and statistical analyses are presented in Appendix G, Tables G-8 through G-9 and Figure G-3. The following narrative results are summarized in Table 4.

b. The gross alpha activity representative MDA is 5 pCi/g. The gross alpha activities ranged from a low of 4.8 pCi/g of soil to a high of 45 pCi/g; the average gross alpha activity was 19.6 pCi/g.

c. The gross beta-gamma representative MDA is 4 pCi/g. The gross beta-gamma activities ranged from a low of 4.8 pCi/g to a high of 23 pCi/g; the average gross beta-gamma activity was 11.3 pCi/g.

d. The gamma spectral analyses indicated the presence of K-40, with activities that ranged from 1.0 to 13 pCi/g and averaged 4.8 pCi/g; Ac-228 with activities that ranged from 0.3 to 3.1 pCi/g and averaged 1.7 pCi/g; Bi-214 with activities that ranged from 0.3 to 2.1 pCi/g and averaged 1.0 pCi/g; and Pb-214 with activities that ranged from 0.3 to 2.2 pCi/g and averaged 1.1 pCi/g.

Table 4. Rattlesnake Gulch Survey Unit Soil Analysis Summary

Analyte	Low (pCi/g)	High (pCi/g)	Average (pCi/g)
Gross Alpha	4.8	45	19.6
Gross Beta-Gamma	4.8	23	11.3
K-40	1.0	13	4.8
Ac-228	0.3	3.1	1.7
Bi-214	0.3	2.1	1.0
Pb-214	0.3	2.2	1.1

F. Data Interpretation - Rattlesnake Gulch Site. The ultimate goal of the decommissioning process is to assure that future uses of any licensed facility will not result in individuals being exposed to unacceptable levels of radiation and/or radioactive materials. This is normally accomplished by ensuring any residual radioactive material is below the release guidelines established by regulatory agencies such as the NRC. These guideline values refer to radiation and radioactivity above normal background levels.

1. Gamma Exposure Rate. The release criteria for direct radiation levels is 5 μR/hr above the established background exposure rate. No exposure rates above background (paragraph VI.D.2.c) were noted. Therefore, the Rattlesnake Gulch Survey Unit meets the release criteria for direct radiation levels.

2. Cobalt-60. The release criteria for Co-60 activity in soil is 8 pCi/g. The Co-60 is not naturally occurring and is not expected to be present in background samples. The T laboratory analyses representative MDA is 0.2 pCi/g. No Co-60 activity above the MDA was detected in samples from the Rattlesnake Gulch Background Area or the Survey Unit. Therefore, the Rattlesnake Gulch survey unit meets the release criteria for Co-60 activity in soil.

3. Cesium-137. The release criteria for Cs-137 activity in soil is 15 pCi/g. The Cs-137 laboratory analyses representative MDA is 0.1 pCi/g. One sample analyzed had an activity greater than the representative MDA. This sample is Sample No. RG E2+2/0 at 0.2 pCi/g. This sample is a core from the mound present and the Cs-137

activity is consistent with those levels expected from fallout. Therefore, the Rattlesnake Gulch survey unit meets the release criteria for Cs-137 in soil.

4. Gross Alpha And Gross Beta-Gamma Measurements. Gross alpha activity and gross beta-gamma activity screening measurements were also performed on the composited soil samples. There are no release criteria for either gross alpha or gross beta-gamma activity measurements. However, if the Rattlesnake Gulch Background Area samples and the Rattlesnake Gulch Survey Unit samples can be shown to be similar radiologically, it can be inferred that they are from the same population. Basic descriptive statistics, including mean, median, standard deviation, variance, etc. were calculated for the gross alpha activity and gross beta-gamma activity measurements from the Rattlesnake Gulch Background Area samples and the Rattlesnake Gulch Survey Unit samples. A statistical summary is presented in Table G-8. Complete descriptive statistics are presented in Table G-9.

a. Gross Alpha Activity Statistical Analyses.

(1) Review of the Rattlesnake Gulch Survey Unit gross alpha activity descriptive statistics indicate a symmetrical or normal distribution since the values of the mean and median (19.6 pCi/g and 19 pCi/g) are comparable. Likewise, the Rattlesnake Gulch Background Area gross alpha activity mean and median (19.5 pCi/g and 18 pCi/g) are indicative of a normal distribution. The standard deviations of the Rattlesnake Gulch Survey Unit and Rattlesnake Gulch Background Area (8.2 pCi/g and 9.9 pCi/g) are comparable.

(2) A parametric hypothesis test, the pooled t-test was used to compare the differences between the two population means. Assumptions required to use the pooled t-test include: Independent samples, normal populations, and equal population standard deviations. The significane level, α, chosen for the hypothesis test was 0.05.

(3) The gross alpha H_0 was: The Rattlesnake Gulch Survey Unit and Rattlesnake Gulch Background Area population means are equal (i.e., $\mu_1 = \mu_2$ and the hypothesized mean difference is zero). The alternative hypotheses was: The population means are not equal. Results of the pooled t-test indicate a t-statistic (-0.07) that was greater than the lower tail critical value (-2.00) and less than the upper tail critical value (2.00) for this test.

Therefore, the H_0 was accepted and the gross alpha activity of the Rattlesnake Gulch Survey Unit is radiologically similar to the Rattlesnake Gulch Background Area.

(4) Results of the Rattlesnake Gulch gross alpha activity hypotesis test is presented in Appendix G, Table G-10.

b. Gross Beta-Gamma Activity Statistical Analyses.

(1) Review of the Rattlesnake Gulch Survey Unit gross beta-gamma activity descriptive statistics indicate a symmetrical or normal distribution since the values of the mean and median (11.3 pCi/g and 11 pCi/g) are comparable. Likewise, the Rattlesnake Gulch Background Area gross beta-gamma activity mean and median (10.8 pCi/g and 10 pCi/g) are indicative of a normal distribution. The standard deviations of the Rattlesnake Gulch Survey Unit and Rattlesnake Gulch Background Area (4.4 pCi/g and 5.1 pCi/g) are comparable.

(2) A parametric hypothesis test, the pooled t-test was used to compare the differences between the two population means. Assumptions required to use the pooled t-test include: Independent samples, normal populations, and equal population standard deviations. The significance level, α, chosen for the hypothesis test was 0.05.

(3) The gross beta-gamma H_0 was: The Rattlesnake Gulch Survey Unit and Rattlesnake Gulch Background Area population means are equal (i.e., $\mu_1 = \mu_2$ and the hypothesized mean difference is zero). The alternative hypotheses was: The population means are not equal. Results of the pooled t-test indicate a t-statistic (-0.4) that was greater than the lower tail critical value (-2.00) and less than the upper tail critical value (2.00) for this test. Therefore, the H_0 was accepted and the gross beta-gamma activity of the Rattlesnake Gulch Survey Unit is radiologically similar to the Rattlesnake Gulch Background Area.

(4) Results of the Rattlesnake Gulch gross beta-gamma activity hypothesis test is presented in Appendix G, Table G-11.

VII. CONCLUSIONS. A review of the survey results indicates that there are no radiological health hazards identified as a result of the 1973 termination of the AEC (now the NRC) licensed operations at the surveyed sites referred to as Iron Mountain and Rattlesnake Gulch, Fort McClellan, Alabama. The survey results indicate that there is no residual radiological contamination above the NRC release criteria and the survey units (surveyed sites) meet the intent of ensuring that future occupants and the environment are not subjected to unacceptable risks from residual radioactivity.

VIII. RECOMMENDATION. Recommend the surveyed sites, referred to as Iron Mountain and Rattlesnake Gulch, be released for unrestricted use.

for Harris Edge
Frances Szrom
Health Physicist
Industrial Health Physics Program

Barthel F. Truffa III
Barthel F. Truffa, III
Health Physics Technician
Henry M. Jackson Participant
Industrial Health Physics Program

APPROVED:

Harris Edge
Harris Edge
Program Manager
Industrial Health Physics Program

APPENDIX A

References

1. Memorandum, CETHA-IR-A, USATHAMA, subject: Request for U.S. Army Environmental Hygiene Agency (AEHA) Support, 7 April 1992.

2. Memorandum, HSHB-MR-HI, USAEHA, subject: Radiological Status of Iron Mountain, Fort McClellan, Alabama, 15 January 1993.

3. Memorandum, SFIM-AEC-TSS, USAEC, subject: Request for Technical Services, 27 December 1993.

4. Memorandum, SFIM-AEC-ETD, USAEC, subject: Request for U.S. Army Center for Health Promotion and Preventive Medicine Support at Fort McClellan, AL, 4 January 1996.

5. Hand written letter, LTC William G. Powell to MAJ Anderson, subject: Personal Recollections and Information on Iron Mountain and Rattlesnake Gulch, 6 March 1971.

6. Industrial Radiation Consultation No. 27-43-EU66-93, U.S. Army Chemical School and Military Police Center and Fort McClellan, Alabama, 27 July 1993.

7. USAEHA Radiation Special Study No. 43-075-73/74, U.S. Army Chemical Center and School, Fort McClellan, AL 36201, 28-31 May 1973.

8. Health Physics Division, USACMLCS, Iron Mountain (Rattlesnake Gulch) Radioactive Material Burial Site, 29 July 1971.

9. Message, ATSCM-HP, USACMLCS, 301659Z Apr 73, subject: Disposition of Radioactive Material, 30 April 1973.

10. Message, ATSCM-HP, USACMLCS, 041630Z Jun 73, subject: Notification of Transfer of Radioactive Material, 4 June 1973.

11. Health Physics Division, USACMLCS, Close-out Log 21 Feb 73 - 31 May 1973.

Indust Radn Study No. 27-MH-0987-R1-96, 27 Feb-15 Mar 95

12. Health Physics Division, USACMLCS, Memorandum for Record, Shipment to EA 4 Jun, 4 June 1973.

13. Message, DALO-MAS-I, No. 1834, 181920Z, subject: Disposition of Radioactive Material, 18 May 1973.

APPENDIX B

Abbreviations

Ac-228	Actinium-228
AEC	Atomic Energy Commission
ASP	Analog Smart Portable
Bi-214	bismuth-214
BML	Byproduct Material License
Co-60	cobalt-60
cpm	counts per minute
Cs-137	cesium-137
DAC	Department of the Army Civilian
ESP	Eberline Smart Portable
GPS	Global Positioning System
H_0	null hypothesis
K-40	potassium-40
MDA	minimum detectable activity
mR/hr	milliRoentgen per hour
μR/hr	microRoentgen per hour
NaI(Tl)	sodium iodide, thallium activated
NRC	Nuclear Regulatory Commission
NUREG/CR	Nuclear Regulatory Guide/Contractor Report
Pb-214	lead-214
pCi/g	picocuries per gram
QA	quality assurance
QC	quality control
RAP	Radioisotope Analysis Program
RPO	Radiation Protection Officer
SN	serial number
SNM	Special Nuclear Material
SOP	Standard Operating Procedure
Sr-90	strontium-90
SSE	South Southeast
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USACMLCS	U.S. Army Chemical Center and School
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
UTM	Universal Transverse Mercator

APPENDIX C

Iron Mountain and Rattlesnake Gulch Environmental Sampling Plan

1. Purpose. The purpose of this Sampling Plan is to adequately address all survey requirements to successfully release the former radioactive material burial grounds known as Iron Mountain and Rattlesnake Gulch, Fort McClellan, Alabama, for unrestricted use.

2. References.

a. NUREG/CR-5849, Manual for Conducting Radiological Surveys in support of License Termination, June 1992.

b. Industrial Radiation Consultation No. 27-43-EU66-93, U.S. Army Chemical School and Military Police Center and Fort McClellan, Alabama, 27 July 1993.

c. Memorandum, HSHB-MR-HI, USAEHA, subject: Radiological Status of Iron Mountain, Fort McClellan, Alabama, 15 January 1993.

d. Handwritten letter, LTC William G. Powell to MAJ Anderson, subject: Personal Recollections and Information on Iron Mountain and Rattlesnake Gulch, 6 March 1971.

e. USAEHA Radiation Special Study No. 43-075-73/74, U.S. Army Chemical Center and School, Fort McClellan, AL 36201, 28-31 May 1973.

3. Historical Data Review Summary.

a. The historical review completed by USACHPPM (previously USAEHA) is the Industrial Radiation Consultation No. 27-43-EU66-93, and serves as an initial indication of the scope of work. It will also serve as the guidance for which aspects of the site sampling plan must be implemented in each specific area.

b. The sites of current concern are two former radioactive material burial grounds located near the Southwest corner of Fort McClellan, Alabama. These burial grounds were used by the U.S. Army Chemical Corps School during the 1950's. In 1959, they were reportedly cleaned up and relocated to a burial ground located at Rideout Field, Pelham Range, Area 24C, Fort McClellan, Alabama.

c. In February 1971, a fenced-in area with "Radiation Area" signs posted around it was discovered in a region referred to as "Rattlesnake Gulch." An extensive effort was initiated to remove and properly dispose of the radioactive materials and radioactive contamination found at this site.

d. The "Rattlesnake Gulch" site has also been referred to as the "Iron Mountain" site. However, examination of personal written recollections indicates the existence of two distinct sites on the geographic feature known as Iron Mountain (Reference 2.d. of this Sampling Plan). The area which will be referred to as the "Iron Mountain" site is located approximately 200m down the northern slope of the Iron Mountain peak. The area which will be referred to as the "Rattlesnake Gulch" site is located approximately 600m down the North Northwestern ridge line from the Iron Mountain peak.

e. The Iron Mountain site was located on the basis of map coordinates referenced in documents associated with the "Rattlesnake Gulch" site. The installation RPO located the map coordinates with a nuclear, biological, chemical reconnaissance vehicle equipped with a military GPS receiver. An area close to these map coordinates was found to have evidence of past burial activity and indications that the vegetation is of recent growth compared to the surrounding environs.

f. Two members of the 1971 Health Physics Division that discovered the Rattlesnake Gulch site were contacted and questioned about the site location. Their independent recollections put the Rattlesnake Gulch site in the vicinity of the old field hot cell referred to in Reference 2.d. of this Sampling Plan. These two members have agreed to assist in locating the site which should be identifiable by the trenching operations and the recent vegetation growth compared to the surrounding environs.

g. The information gathered from historical documents, and written recollections of personnel assigned to Fort McClellan during the time period in question, indicate the waste which was removed from these sites was most likely laboratory waste (Cs-137, some Co-60, and possibly Sr-90). The information available indicates the waste was loose laboratory waste, containerized laboratory waste (in Super Tropical Bleach cans), and contaminated dirt, buried approximately 6-8 feet below the surface.

(1) Soil contamination and possibly groundwater are the potential concerns.

(2) The isotopes of concern are Cs-137, Co-60, and Sr-90. Samples will be submitted for gross alpha/beta counting and gamma spectral analysis to identify naturally occurring and man-made isotopes. Elevated beta counting results may require radiochemical determination of Sr-90.

4. Description of Location.

a. The Iron Mountain site is located in the Southwest corner of Fort McClellan on the geographic feature known as Iron Mountain and adjacent to an inactive range impact area. The area is approximately 150 feet long by 90 feet wide at map coordinates 610250m East, 3728960 m North in the UTM Zone 16. The area surrounding the site is remote, and access is by a fire trail not identified on the military map of Fort McClellan, Alabama.

b. The Rattlesnake Gulch site is located in the Southwest corner of Fort McClellan on the geographic feature known as Iron Mountain and adjacent to the Old Biological Defense Training Area (currently a land navigation course). The area is approximately 150 feet long by 90 feet wide near map coordinates 610100m East, 3729400m North in the UTM Zone 16. The area surrounding the site is remote, and access is by fire trail not identified on the military map of Fort McClellan, Alabama.

c. These sites have been categorized as unaffected open land areas as defined in NUREG/CR-5849, based on reported waste removals and previous close-out clearances by USAEHA (Reference 2.e. of this Sampling Plan) and AEC.

d. "Affected" and "unaffected" areas classify survey units by contamination potential.

5. Sampling Plan. This sampling plan consists of procedures for performing environmental background surveys, and for performing radiological surveys on site specific areas. Procedures used during all surveys will comply with the survey procedures outlined in NUREG/CR-5849. This sampling plan is developed to comply with the guidance outlined for an "unaffected" open land area as defined in NUREG/CR-5849.

5.1. Background Survey. Background areas will be selected close to but up gradient from each site. The background area sites will be similar to the actual survey sites both geographically and geologically.

a. Procedures.

(1) Background instrumentation surveys and soil samples will be collected from unimpacted areas where the topsoil has not been recently disturbed.

(2) All instrumentation will have operational checks performed with an appropriate radioactive check source prior to shipping to the field site; before starting the survey and during the scheduled site survey.

(3) All gamma surveys are to be performed with the gamma detector at approximately 1m from the soil surface.

(4) All soil samples will be analyzed for gross alpha, gross beta-gamma, and gamma emitting isotope activities. All sample locations will be posted/marked with an identifiable marker, such as a flag or stake.

(5) The area will be marked into two 30 feet by 30 feet grids with sampling locations in the center of each grid and at the midpoint between the grid center and grid corners (this pattern is typically referred to as the standard "Z" pattern). A core sampler will then sample these 10 background points to 12 feet below the soil surface. The core samples will be taken in 2 foot intervals (i.e., 2-4 feet, 6-8 feet, and 10-12 feet) below the soil surface. Core sampling will be in accordance with the appropriate equipment manufacturer's operating instructions.

(6) Water samples will not be collected from these areas (no surface, well, or tap water sources are available at these sites).

(7) Air samples may be collected when appropriate to assist in determining potential radionuclide airborne concentrations. If it is determined that air sampling is necessary, the installation RPO will perform the sampling and preliminary analysis according to local requirements.

5.2. Iron Mountain and Rattlesnake Gulch Surveys. The Iron Mountain and Rattlesnake Gulch areas have been classified as Unaffected Open Land Areas as defined in NUREG/CR-5849. These areas are classified as unaffected on the basis of previous remediation efforts and clearance by USAEHA (Reference 2.e. of this Sampling Plan) and AEC.

a. Instrumentation Survey. Field survey meters will be within current calibration. All survey meters will have operational checks performed on them with an appropriate radioactive check source prior to starting the field surveys, and periodically during the survey work.

(1) The sites will be scanned with a gamma survey meter matched with a thin crystal sodium iodide detector. The detector will be held within 6 inches of the soil surface, and passed from side to side while advancing at a rate not to exceed 0.5m per second. A minimum of 10% of each site will be scanned.

(2) Areas with count rates greater than twice the measured background will be flagged.

(3) After the core samples have been removed (see Soil Samples, paragraph 5.2.b.), the boreholes will be logged with a sodium iodide detector every 2 feet (approximately 0.61m) beginning at 1 foot below the soil surface to the bottom of the borehole. The detector reading will be zeroed at each position and allowed to acquire counts for a minimum of 1 minute. The instrument reading will then be recorded with the location information.

b. Soil Samples. All soil samples collected will be submitted for laboratory analysis for gross alpha, gross beta-gamma, and gamma emitting isotope activities. Core samples will be collected in a systematic "Z" pattern on 30 foot square grids. A graphical representation of the pattern and the numbering system is attached as Figure 1. Since burial trenches were normally 6-8 feet deep during this time frame, each core location will be sampled to a maximum core depth of 12 feet below the surrounding surface (any raised or mounded areas would be in addition to the 12 feet below the surrounding surface).

c. Water Samples. Fort McClellan currently has no Ground Water Monitoring Wells, surface water sources, or tap water sources in vicinity of the Iron Mountain or Rattlesnake Gulch sites.

d. Air Samples. If it is determined that air sampling is necessary, the installation RPO will perform the sampling and preliminary analysis according to local requirements.

6. Laboratory Analysis. All laboratory analyses will be performed by USACHPPM, Radioisotope Analysis Program (RAP), which maintains multiple certifications including the EPA and A2LA.

a. Samples will be analyzed in accordance with USACHPPM, RAP protocols and procedures. Soil samples analysis will be performed at USACHPPM.

b. All laboratory samples will be controlled IAW USACHPPM chain of custody protocol.

7. Quality Assurance and Quality Control (QA and QC).

a. Field survey instruments will be checked daily with a radioactive check source before use. Field QA will consist of blank samples since split and duplicate samples are not feasible with the sampling method to be used.

b. The QA for laboratory instruments will be performed by RAP, USACHPPM. Laboratory QA/QC such as sample spikes and background controls will be implemented by RAP, as appropriate.

8. Sample Contamination Management.

a. Disposable gloves and splash protective apparel (i.e., saranex aprons, face shields) will be worn when appropriate. Since the soil sampling method effectively isolates each sample, gloves will be changed when integrity is compromised or monitoring results indicate contamination.

b. Sample collection equipment will be cleaned between each sample.

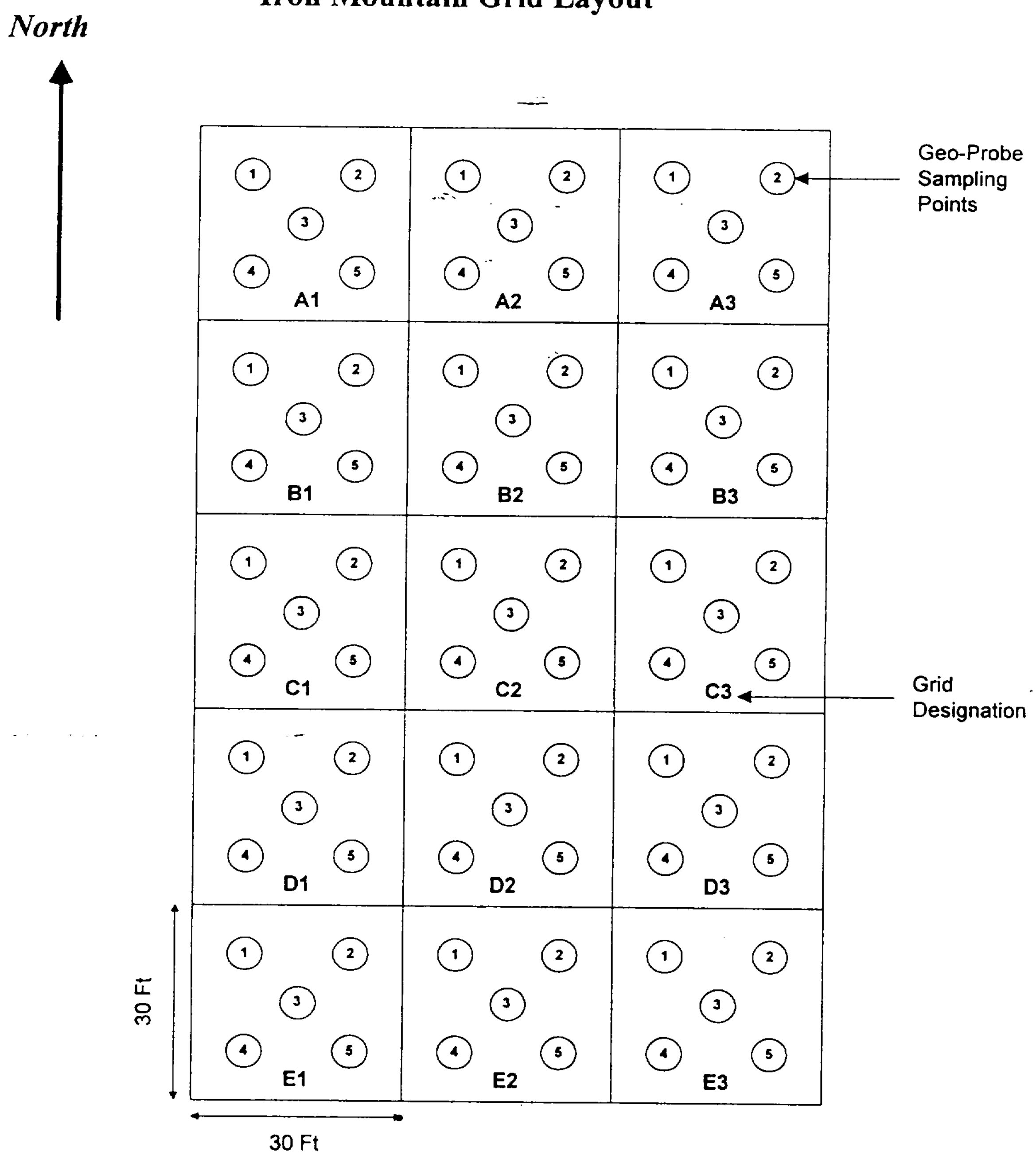
c. All sample tubes will be monitored, capped with a black cap on the bottom and a red cap on the top, labeled, and placed in a lockable container [keys controlled by the sample custodian(s)]. Samples will be returned to USACHPPM with the survey equipment and vehicles.

9. General Safety Plan. General site safety is covered in Appendix D.

10. Survey Data. Survey and laboratory data will be used to provide recommendations for release of the site for unrestricted use or site remediation work plans. If radiological contamination is observed above acceptable levels, USACHPPM will provide necessary recommendations to assist in the remediation effort.

Figure 1.

Iron Mountain Grid Layout



APPENDIX D

SITE SAFETY PLAN
IRON MOUNTAIN & RIDEOUT FIELD SITES
FORT MCCLELLAN, ALABAMA
PROJECT NUMBER 27-83-0987
FEBRUARY 1995 - MARCH 1995

1. INTRODUCTION. Safety is the responsibility of everyone involved in every aspect of this survey. It will be the number one concern and under no circumstance will any compromises be made on established safety standards.

2. ORGANIZATION AND RESPONSIBILITIES.

a. Harris Edge
Program Manager
Industrial Health Physics Program
U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)

b. Frances Szrom
Project and Site Safety Manager
USACHPPM

c. James S. Bradley
Co-Project and Site Safety Manager
USACHPPM

d. Barthel F. Truffa, III
Health Physics Consultant
Technical Consulting Services

e. I. Richard Kestner
Engineering Technician
USACHPPM

f. Rocky Hoover
Engineering Technician
USACHPPM

g. Michael Stewart
Medical Laboratory Technician
USACHPPM

3. WORK PLAN.

a. Purpose. The purpose of these radiological termination surveys is to produce the data to demonstrate that all radiological parameters are in compliance with current applicable Federal, State and local radiological guidelines for release of the areas for unrestricted use.

b. Project Description. Two locations at Fort McClellan, AL, designated as Iron Mountain and Rideout Field, had been used as radioactive waste burial sites (1950's). These areas had waste buried in trenches approximately 6 feet deep. Records indicate the waste was removed (1970's) and disposed at Nuclear Regulatory Commission (NRC) disposal facilities. However, adequate termination surveys were not performed. Therefore, termination surveys will be performed following the guidelines currently available in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination". Soil samples are required from various depths. Equipment, such as the GeoProbe, which is a hydraulic push sampler, will be used to collect the samples. The Iron Mountain site is located in a wooded area that has re-vegetated since the 1970's. The Rideout Field site contains a mound (approximately 6 feet high) located in an open field area.

c. Personnel. The personnel that will be involved on site are listed in paragraphs 2b through 2g above. Either the project manager or co-project manager will be present during on site operations. While on site the survey team will be accompanied by Fort McClellan safety qualified personnel, as designated by the installation safety manager.

d. Medical Surveillance. All USACHPPM personnel involved in this survey are included in the medical monitoring program through Kirk Army Health Clinic at Aberdeen Proving Ground - Edgewood, Maryland.

4. SITE SPECIFIC HAZARD ANALYSIS.

a. Biological Hazards. Snakes, ticks, and other pests are typically found in wooded and field areas in the Fort McClellan area. To reduce the problems associated with such pests this survey is being performed during the winter months.

b. Chemical Hazards. None apparent.

c. Climatic Hazards/Temperature. Given the timing of this study, cold weather may present a problem. Warm clothing and frequent work breaks will be used to mitigate cold weather effects. However, if conditions warrant, such as extremely low temperatures, heavy rain or wind, work will cease until conditions improve.

d. Electrical/Utility. None apparent.

e. Flammable/Explosive. None apparent.

f. Ordnance. The Iron Mountain site is at the edge of an inactive range. A sweep for unexploded ordnance was performed by the 142nd EOD unit in January 1995. No ordnance was found and a copy of their report will be appended to this site safety plan. Work will not begin at the Iron Mountain site until that report is provided to USACHPPM personnel. However, the possibility for unexploded ordnance still exists. Therefore, a Fort McClellan safety qualified person will accompany the survey team.

g. Infectious. None apparent.

h. Oxygen/Confined Space. None apparent.

i. Physical Hazards. Numerous physical hazards are associated with hydraulic push sampling equipment. Care will be taken at all times and instructions for safe and proper operation from the equipment operators will be followed by all survey personnel at all times.

j. Noise. Noise is a concern for the equipment operator and nearby personnel. Therefore, the operator and nearby personnel will wear ear plugs/muffs.

k. Radioactive. Radioactive hazards are minimal, since all contamination is believed to have been removed from these areas. All areas will be entered with radiation survey equipment turned on. Samples and sampling equipment will be surveyed as an integral part of the sampling procedures. Should the survey equipment indicate radiation fields of 2 millirad per hour (2 mrad/hr) or greater, the area will not be entered until consulting with the local Radiation Protection Officer (RPO). The need for personnel dosimeters and contamination control procedures will then be readdressed.

l. Personal Protective Equipment. Steel toed safety boots/shoes will be worn at all times. Safety glasses will be worn as necessary. Ear plugs/muffs will be worn as necessary. Hard hats will be worn by the equipment operator and nearby personnel. Light duty work gloves will be used if field radiation survey equipment indicate readings less than 2 times background. Latex gloves will be used while sampling, if field radiation survey equipment indicate readings 2-3 times background readings.

m. Decontamination Procedures. Sampling equipment will be decontaminated with brushes and tap water rinses.

n. Emergency Procedures. The Fort McClellan safety qualified person accompanying the survey team will provide remote communications to all necessary Fort McClellan and local emergency personnel. Illnesses and injuries will be directed to the local medical support center.

5. NOTIFICATION. Pre-entry safety and work briefings will be held prior to daily work commencement. The briefings will consist of the familiarization of project personnel with the sampling locations and methodologies, site safety procedures, and emergency response procedures. The following individuals acknowledge that they have been notified of the contents of this site safety and health plan, understand its requirements, and agree to comply with the identified procedures:

Name	Signature	Date
Frances Szrom	Frances Szrom	23 Feb 95
James S. Bradley	J S Bradley	6 FEB 95
Barthel F. Truffa, III	Barthel F Truffa III	23 Feb 95
I. Richard Kestner	I Richard Kestner	23 Feb 95
Rocky Hoover	R. Hoover	23 Feb 95
Michael Stewart	M Stewart	

PREPARED BY:

Frances Szrom 23 Feb 95
FRANCES SZROM DATE
Project Manager/Site Safety Manager
Industrial Health Physics Program
USACHPPM

REVIEWED BY:

Harris Edge 23 Feb 95
HARRIS EDGE DATE
Program Manager
Industrial Health Physics Program
USACHPPM

CONCURRENCE BY:

Creighton P. Jacobson 23 Feb 95
CREIGHTON P. JACOBSON DATE
Safety and Occupational Health Manager
USACHPPM

John W. May 27 Feb 95
JOHN W. MAY DATE
Health Physicist
Radiation Protection Officer
Fort McClellan, Alabama

DEPARTMENT OF THE ARMY
142D ORDNANCE DETACHMENT (EOD)
FORSCOM FIELD OPERATING ACTIVITY (G3)
FORT MCCLELLAN, ALABAMA 36205

AFBY-CJ (75-15)

11 Jan 95

MEMORANDUM FOR Commander, U.S. Army Chemical School, ATTN: ATZN-CM-AHP, Radiation Protection Officer, Fort McClellan, AL 36205

SUBJECT: Surface Clearance of Iron Mountain

1. A surface clearance of the Iron Mountain area was conducted 11 Jan 95. No ordnance was found.

2. Recommend Army Environmental Hygiene Agency request EOD support to accompany them during survey operations, ordnance may be discovered that was not detected during initial range clearance operations.

3. Point of contact is SSG Woodford at 848-5124/5430.

Van R. Craig

VAN R. CRAIG
2LT, OD
Commanding

APPENDIX E

Instrumentation and Laboratory Analyses

1. Survey Instrumentation Used:

a. Eberline Smart Portable (ESP), Model ESP-2, SN 355: calibrated 19 January 1995. The ESP-2 was mated with the following radiation detectors:

(1) Eberline Model SPA-3 Scintillation Probe Assembly for measuring gamma exposure rate.

(2) Eberline Model HP-270 energy compensated metal GM detector for measuring gamma exposure rate and detecting beta radiation.

b. Eberline Smart Portable (ESP), Model ESP-2, SN 1447 calibrated 7 December 1994. The ESP-2 was mated with the following radiation detectors:

(1) Eberline Model HP-210T tungsten shielded thin window GM detector for measuring beta-gamma count rates.

(2) Eberline Model AC-3 Zinc Sulfide Scintillation detector for detecting alpha count rates.

(3) Eberline Model SPA-3 Scintillation Probe Assembly for measuring gamma exposure rate.

c. Eberline Analog Smart Portable (ASP), Model ASP-1, SN 2871 calibrated 11 October 1994. The ASP-1 was mated with the following radiation detector: Eberline Model PG-2 plutonium gamma thin crystal sodium iodide detector for detection of low energy gamma and x-rays.

d. Ludlum Model 2350 Data Logger, SN 98629, calibrated 1 February 1995. The 2350 was mated to the following detector:

Ludlum Model 44-2 1-inch by 1-inch Sodium Iodide detector, SN PR 109560, for the measurement of gamma exposure rates.

2. Laboratory Instrumentation Used:

a. Tennelec Model LB 5100, Alpha/Beta Gas-flow Proportional Counting System, SN: 52259-1.

b. Tennelec Model LB 5100, Alpha/Beta Gas-flow Proportional Counting System, SN: 57259-2.

c. Ortec Gamma Spectral Analyzer, Model GEM-LB-47220-S, with High Purity Germanium Detector, SN: 25-P-95S.

d. Ortec Gamma Spectral Analyzer, Model GMX-15185-S, with High Purity Germanium Detector, SN: 22-N-71XA.

3. Laboratory Analyses.

a. Wipe Test Analyses. These sites were open outdoor areas, no wipe tests were collected for analysis.

b. Soil Samples.

(1) Gross Alpha and Gross Beta. Each soil sample was placed into individual beakers. The soil was dried in a forced air furnace. After allowing to dry overnight, all rocks, plant roots, and other materials were screened from the soil. Samples from the same grid and like depth interval were then composited. An aliquot of one-tenth of a gram was removed and placed in a pre-weighed planchet. The sample was counted in a gas flow proportional counter for gross alpha and gross beta activity. Efficiency and absorption factors are calculated using the efficiency curves from gross alpha/beta in water, EPA-600/4-80-032 method 900.0. In addition, duplicate analyses were performed on several soil samples.

(2) Gamma Spectral Analyses. Each soil sample was placed in individual beakers and dried in a forced air furnace. After allowing to dry overnight, all rocks, plant roots and other

materials were screened from the soil. The soil was placed in a container and placed on the gamma spectral analyzer detector. Each soil sample was counted for 100 minutes. Results for Co-60, Cs-137, K-40, Ac-228, Bi-214, and Pb-214 are reported.

APPENDIX F

TABLE F-1. Iron Mountain Exposure Rate Measurements

Iron Mountain Background Area					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
IM BKG A1	5.16	5.28	5.26	5.76	5.65
IM BKG A2	4.99	4.98	5.12	5.11	5.31
Iron Mountain Survey Unit					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
IM A1	4.43	4.38	4.52	5.49	4.77
IM A2	4.19	4.30	4.22	4.77	5.60
IM A3	4.64	4.70	5.14	5.83	5.85
IM B1	5.48	5.49	5.66	5.94	5.70
IM B2	5.49	5.84	5.64	5.87	6.01
IM B3	6.63	6.48	6.75	6.29	6.16
IM C1	5.46	5.59	5.32	4.09	4.71

TABLE F-1. Iron Mountain Exposure Rate Measurements (Continued)

Iron Mountain Survey Unit (Continued)					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
IM C2	5.39	5.36	5.24	5.16	4.87
IM C3	5.43	5.46	4.81	5.09	5.04
IM D1	4.35	4.06	4.56	4.74	4.49
IM D2	4.42	4.86	4.74	4.51	4.42
IM D3	4.59	5.20	4.70	4.59	4.93
IM E1	4.63	4.48	4.57	4.47	4.54
IM E2	4.90	4.38	4.58	4.38	4.60
IM E3	4.57	4.75	4.96	4.86	4.89

Table F-2. Rattlesnake Gulch Exposure Rate Measurements

Rattlesnake Gulch Background Area					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
RG BKG A1	4.46	4.53	4.22	4.54	4.30
RG BKG A2	4.46	4.20	4.34	4.55	4.30
Rattlesnake Gulch Survey Unit					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
RG A1	3.65	3.33	3.67	3.85	3.71
RG A2	3.15	3.34	3.31	3.17	3.19
RG A3	3.28	3.60	3.60	3.46	3.43
RG B1	3.93	3.42	4.15	3.37	3.44
RG B2	3.37	3.24	3.14	3.35	3.18
RG B3	3.55	3.44	3.41	3.04	3.59
RG C1	3.88	3.59	3.47	4.04	3.51

Table F-2. Rattlesnake Gulch Exposure Rate Measurements (Continued)

Rattlesnake Gulch Survey Unit (Continued)					
Grid	Exposure Rate Measurements at 1 meter (μR/hr)				
	Location -1	Location -2	Location -3	Location -4	Location -5
RG C2	3.58	3.07	3.47	3.23	3.20
RG C3	3.02	3.26	3.11	3.23	3.23
RG D1	4.01	3.63	4.13	3.96	3.44
RG D2	3.52	2.95	3.35	3.45	3.43
RG D3	3.06	3.92	2.98	2.91	3.20
RG E1	3.87	3.77	3.50	3.79	3.48
RG E2	3.31	3.18	3.16	3.33	3.17
RG E3	3.05	3.07	3.15	3.21	3.44

TABLE F-3. Iron Mountain Laboratory Results

		Microcuries per Gram		Picocuries per Gram					
Sample	Lab	+/- 2 Standard Deviations		+/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
IM BKG A1-1 2/4	V4742	(1.8 +/- 0.6)E-05	(3.2 +/- 0.4)E-05	23 +/- 3	2.8 +/- 0.8	1.3 +/- 0.3	1.1 +/- 0.3	0.04 +/- 0.1	-0.06 +/- 0.09
IM BKG A1-2 2/4	V4743	(2.5 +/- 0.7)E-05	(2.9 +/- 0.4)E-05	23 +/- 2	2.4 +/- 0.4	1.2 +/- 0.2	1.2 +/- 0.2	-0.04 +/- 0.06	0.02 +/- 0.06
IM BKG A1-3 2/4	V4744	(2.3 +/- 0.6)E-05	(1.9 +/- 0.4)E-05	13 +/- 3	2.2 +/- 0.6	1.0 +/- 0.4	0.9 +/- 0.3	0.08 +/- 0.1	-0.02 +/- 0.09
IM BKG A1-4 2/4	V4745	(2.4 +/- 0.6)E-05	(4.4 +/- 0.5)E-05	38 +/- 3	2.3 +/- 0.5	1.2 +/- 0.3	1.6 +/- 0.3	-0.07 +/- 0.07	-0.01 +/- 0.07
IM BKG A1-5 2/4	V4746	(3.5 +/- 0.8)E-05	(2.3 +/- 0.4)E-05	14 +/- 3	2.2 +/- 0.6	1.3 +/- 0.3	1.4 +/- 0.3	-0.002 +/- 0.1	0.008 +/- 0.1
IM BKG A1-1 6/8	V4747	(3.4 +/- 0.8)E-05	(4.4 +/- 0.5)E-05	39 +/- 3	2.9 +/- 0.5	1.2 +/- 0.3	1.3 +/- 0.3	0.03 +/- 0.09	-0.07 +/- 0.06
IM BKG A1-2 6/8	V4748	(2.2 +/- 0.6)E-05	(2.5 +/- 0.4)E-05	20 +/- 3	2.0 +/- 0.7	1.3 +/- 0.3	1.0 +/- 0.3	-0.2 +/- 0.1	0.005 +/- 0.1
IM BKG A1-3 6/8	V4749	(2.5 +/- 0.7)E-05	(2.9 +/- 0.4)E-05	26 +/- 2	2.2 +/- 0.5	1.5 +/- 0.2	1.5 +/- 0.2	-0.002 +/- 0.07	-0.02 +/- 0.07
IM BKG A1-4 6/8	V4750	(2.3 +/- 0.6)E-05	(2.0 +/- 0.4)E-05	16 +/- 2	2.8 +/- 0.4	1.0 +/- 0.2	1.0 +/- 0.2	0.02 +/- 0.06	0.005 +/- 0.06
IM BKG A1-5 6/8	V4751	(3.0 +/- 0.7)E-05	(3.1 +/- 0.4)E-05	19 +/- 3	2.9 +/- 0.7	1.1 +/- 0.3	1.2 +/- 0.4	0.1 +/- 0.1	0.02 +/- 0.1
IM BKG A1-2 10/12	V4752	(3.1 +/- 0.7)E-05	(5.6 +/- 0.5)E-05	54 +/- 3	2.3 +/- 0.6	1.1 +/- 0.3	1.4 +/- 0.2	0.02 +/- 0.09	0.002 +/- 0.07
IM BKG A1-2 10/12 DUP	V4752	(3.5 +/- 0.8)E-05	(5.8 +/- 0.5)E-05						
IM BKG A1-3 10/12	V4753	(3.6 +/- 0.8)E-05	(4.8 +/- 0.5)E-05	44 +/- 5	2.7 +/- 0.9	1.4 +/- 0.4	1.6 +/- 0.4	-0.1 +/- 0.2	0.001 +/- 0.1
IM BKG A1-4 10/12	V4754	(3.4 +/- 0.7)E-05	(5.3 +/- 0.5)E-05	47 +/- 3	2.5 +/- 0.5	1.9 +/- 0.3	2.0 +/- 0.3	-0.01 +/- 0.1	-0.03 +/- 0.07
IM BKG A1-5 10/12	V4755	(2.2 +/- 0.6)E-05	(3.7 +/- 0.4)E-05	28 +/- 4	2.3 +/- 0.6	0.9 +/- 0.3	1.1 +/- 0.3	0.02 +/- 0.1	-0.07 +/- 0.1
IM BKG A2-1 2/4	V4756	(2.5 +/- 0.6)E-05	(2.3 +/- 0.4)E-05	15 +/- 2	2.5 +/- 0.4	1.4 +/- 0.3	1.7 +/- 0.3	0.03 +/- 0.07	-0.02 +/- 0.07
IM BKG A2-2 2/4	V4757	(2.5 +/- 0.7)E-05	(1.5 +/- 0.3)E-05	5 +/- 2	2.7 +/- 0.7	0.9 +/- 0.4	1.1+/- 0.3	-0.01 +/- 0.1	0.009 +/- 0.09
IM BKG A2-3 2/4	V4758	(1.6 +/- 0.5)E-05	(1.2 +/- 0.3)E-05	6 +/- 1	2.2 +/- 0.4	1.1 +/- 0.3	1.3 +/- 0.2	0.03 +/- 0.05	-0.02 +/- 0.05
IM BKG A2-4 2/4	V4759	(2.2 +/- 0.6)E-05	(1.5 +/- 0.3)E-05	8 +/- 1	2.3 +/- 0.4	1.0 +/- 0.2	1.0 +/- 0.2	0.03 +/- 0.06	-0.04 +/- 0.06
IM BKG A2-5 2/4	V4760	(3.1 +/- 0.7)E-05	(1.2 +/- 0.3)E-05	5 +/- 2	2.8 +/- 0.6	1.1 +/- 0.4	1.3 +/- 0.4	0.05 +/- 0.1	0.04 +/- 0.1
IM BKG A2-1 6/8	V4761	(2.0 +/- 0.6)E-05	(3.0 +/- 0.4)E-05	17 +/- 2	2.6 +/- 0.5	1.1 +/- 0.2	1.1 +/- 0.3	0.007 +/- 0.07	-0.03 +/- 0.06
IM BKG A2-2 6/8	V4762	(2.6 +/- 0.7)E-05	(1.9 +/- 0.3)E-05	15 +/- 3	2.5 +/- 0.8	1.2 +/- 0.3	1.5 +/- 0.3	0.03 +/- 0.1	0.05 +/- 0.1
IM BKG A2-4 6/8	V4763	(2.2 +/- 0.6)E-05	(2.8 +/- 0.4)E-05	25 +/- 2	2.1 +/- 0.5	1.2 +/- 0.2	1.5 +/- 0.3	-0.03 +/- 0.08	-0.03 +/- 0.06
IM BKG A2-5 6/8	V4764	(2.4 +/- 0.6)E-05	(1.8 +/- 0.3)E-05	5 +/- 2	1.9 +/- 0.6	0.8 +/- 0.3	1.0 +/- 0.3	0.03 +/- 0.1	0.03 +/- 0.1
IM BKG A2-1 10/12	V4765	(2.4 +/- 0.6)E-05	(3.5 +/- 0.4)E-05	30 +/- 3	2.2 +/- 0.5	1.4 +/- 0.2	1.3 +/- 0.3	0.03 +/- 0.08	-0.03 +/- 0.06

TABLE F-3. Iron Mountain Laboratory Results (Continued)

Sample	Lab	Microcuries per Gram +/- 2 Standard Deviations		Picocuries per Gram +/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
IM BKG A2-2 10/12	V4766	(3.2 +/- 0.7)E-05	(3.5 +/- 0.4)E-05	21 +/- 4	2.4 +/- 0.8	1.3 +/- 0.4	1.2 +/- 0.4	0.09 +/- 0.1	-0.01 +/- 0.09
IM BKG A2-2 10/12 DUP	V4766	(3.0 +/- 0.7)E-05	(3.4 +/- 0.4)E-05						
IM BKG A2-3 10/12	V4767	(3.3 +/- 0.7)E-05	(3.5 +/- 0.4)E-05	26 +/- 2	3.6 +/- 0.7	1.6 +/- 0.3	1.9 +/- 0.3	0.02 +/- 0.07	-0.004 +/- 0.08
IM BKG A2-4 10/12	V4768	(2.2 +/- 0.6)E-05	(3.7 +/- 0.4)E-05	22 +/- 4	2.1 +/- 0.7	1.4 +/- 0.4	1.3 +/- 0.3	-0.02 +/- 0.1	0.02 +/- 0.1
IM BKG A2-5 10/12	V4769	(2.2 +/- 0.6)E-05	(1.9 +/- 0.3)E-05	8 +/- 2	2.0 +/- 0.4	1.4 +/- 0.2	1.7 +/- 0.3	-0.02 +/- 0.05	-0.07 +/- 0.06
IM A1 2/4	V4770	(2.3 +/- 0.6)E-05	(1.5 +/- 0.3)E-05	7 +/- 1	1.9 +/- 0.4	1.1 +/- 0.2	1.1 +/- 0.2	0.06 +/- 0.06	-0.02 +/- 0.06
IM A1 6/8	V4771	(3.3 +/- 0.7)E-05	(1.9 +/- 0.3)E-05	11 +/- 3	2.2 +/- 0.7	1.2 +/- 0.5	1.1 +/- 0.3	0.2 +/- 0.1	-0.06 +/- 0.09
IM A1 10/12	V4772	(3.7 +/- 0.8)E-05	(3.1 +/- 0.4)E-05	25 +/- 2	2.3 +/- 0.4	2.0 +/- 0.3	2.1 +/- 0.3	0.02 +/- 0.07	0.004 +/- 0.07
IM A2-5 +2/0	V4773	(1.8 +/- 0.6)E-05	(1.1 +/- 0.3)E-05	6 +/- 2	2.2 +/- 0.9	1.7 +/- 0.5	1.8 +/- 0.5	0.08 +/- 0.2	0.8 +/- 0.3
IM A2 2/4	V4774	(1.8 +/- 0.6)E-05	(7.1 +/- 2.6)E-06	1.0 +/- 0.6	2.1 +/- 0.4	0.9 +/- 0.2	1.0 +/- 0.2	0.04 +/- 0.04	0.06 +/- 0.05
IM A3 2/4	V4775	(2.1 +/- 0.6)E-05	(9.3 +/- 2.7)E-06	0.1 +/- 1.3	1.8 +/- 0.4	0.8 +/- 0.3	1.0 +/- 0.3	0.04 +/- 0.1	0.02 +/- 0.08
IM A3 6/8	V4776	(2.0 +/- 0.6)E-05	(1.3 +/- 0.3)E-05	2 +/- 1	2.3 +/- 0.4	0.9 +/- 0.2	1.3 +/- 0.2	0.006 +/- 0.04	-0.01 +/- 0.06
IM A3 6/8 DUP	V4776	(1.9 +/- 0.6)E-05	(1.3 +/- 0.3)E-05						
IM A3 9/11	V4777	(1.7 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	4 +/- 2	1.9 +/- 0.5	0.7 +/- 0.4	1.3 +/- 0.3	0.02 +/- 0.08	0.01 +/- 0.09
IM B1 2/4	V4778	(2.4 +/- 0.6)E-05	(3.2 +/- 0.4)E-05	26 +/- 2	2.0 +/- 0.4	1.2 +/- 0.3	1.4 +/- 0.3	-0.04 +/- 0.07	-0.01 +/- 0.06
IM B1 6/8	V4779	(2.4 +/- 0.6)E-05	(4.2 +/- 0.5)E-05	32 +/- 3	1.9 +/- 0.5	1.8 +/- 0.3	1.9 +/- 0.3	-0.004 +/- 0.07	0.04 +/- 0.07
IM B1 9/11	V4780	(2.7 +/- 0.7)E-05	(3.8 +/- 0.4)E-05	36 +/- 4	1.9 +/- 0.8	1.9 +/- 0.4	1.8 +/- 0.4	-0.03 +/- 0.1	-0.09 +/- 0.1
IM B2-1 +1/0	V4781	(2.1 +/- 0.6)E-05	(1.3 +/- 0.3)E-05	2 +/- 1	2.0 +/- 0.4	1.4 +/- 0.2	1.5 +/- 0.3	-0.03 +/- 0.06	1.4 +/- 0.2
IM B2 2/4	V4782	(2.0 +/- 0.6)E-05	(9.6 +/- 2.7)E-06	2 +/- 1	2.2 +/- 0.6	0.9 +/- 0.4	1.0 +/- 0.3	-0.03 +/- 0.1	-0.07 +/- 0.1
IM B2 6/8	V4783	(2.5 +/- 0.7)E-05	(1.5 +/- 0.3)E-05	7 +/- 1	2.4 +/- 0.4	1.0 +/- 0.2	1.3 +/- 0.2	-0.009 +/- 0.06	-0.02 +/- 0.06
IM B2 9/11	V4784	(1.5 +/- 0.5)E-05	(1.5 +/- 0.3)E-05	7 +/- 2	2.1 +/- 0.6	0.9 +/- 0.3	1.1 +/- 0.3	-0.0005 +/- 0.1	-0.08 +/- 0.09
IM B2 9/11 DUP	V4784	(2.3 +/- 0.6)E-05	(1.4 +/- 0.3)E-05						
IM B3 2/4	V4785	(1.4 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	2 +/- 1	1.7 +/- 0.3	0.7 +/- 0.2	0.9 +/- 0.2	-0.003 +/- 0.04	-0.04 +/- 0.05
IM B3 6/8	V4786	(2.2 +/- 0.6)E-05	(1.0 +/- 0.3)E-05	4 +/- 2	1.9 +/- 0.5	0.7 +/- 0.3	0.9 +/- 0.3	0.06 +/- 0.08	0.04 +/- 0.09
IM B3 9/11	V4787	(2.9 +/- 0.7)E-05	(2.5 +/- 0.4)E-05	17 +/- 2	1.7 +/- 0.5	1.1 +/- 0.2	1.5 +/- 0.2	0.03 +/- 0.06	0.02 +/- 0.06
IM C1 2/4	V4788	(2.0 +/- 0.6)E-05	(2.0 +/- 0.3)E-05	11 +/- 3	2.0 +/- 0.7	1.0 +/- 0.4	0.8 +/- 0.4	0.1 +/- 0.1	0.03 +/- 0.09

TABLE F-3. Iron Mountain Laboratory Results (Continued)

Sample	Lab	Microcuries per Gram +/- 2 Standard Deviations		Picocuries per Gram +/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
IM C1 6/8	V4789	(2.0 +/- 0.6)E-05	(4.1 +/- 0.5)E-05	33 +/- 3	2.0 +/- 0.4	1.5 +/- 0.3	1.6 +/- 0.3	0.04 +/- 0.08	0.02 +/- 0.06
IM C1 9/11	V4790	(2.0 +/- 0.6)E-05	(3.5 +/- 0.4)E-05	29 +/- 4	2.8 +/- 0.7	1.3 +/- 0.4	1.7 +/- 0.4	0.07 +/- 0.1	0.04 +/- 0.1
IM C2-1 +1/0	V4791	(2.2 +/- 0.6)E-05	(1.3 +/- 0.3)E-05	2 +/- 1	1.5 +/- 0.5	0.9 +/- 0.4	1.1 +/- 0.3	-0.05 +/- 0.1	0.2 +/- 0.1
IM C2 2/4	V4792	(1.3 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	2 +/- 1	1.8 +/- 0.4	0.9 +/- 0.2	1.1 +/- 0.2	0.02 +/- 0.05	0.05 +/- 0.06
IM C2 6/8	V4793	(1.5 +/- 0.5)E-05	(1.3 +/- 0.3)E-05	6 +/- 2	2.0 +/- 0.5	0.8 +/- 0.3	1.1 +/- 0.3	0.03 +/- 0.1	-0.1 +/- 0.09
IM C2 9/11	V4794	(2.6 +/- 0.7)E-05	(3.3 +/- 0.4)E-05	23 +/- 2	1.6 +/- 0.5	1.3 +/- 0.3	1.4 +/- 0.2	0.02 +/- 0.06	-0.01 +/- 0.06
IM C2 9/11 DUP	V4794	(2.5 +/- 0.7)E-05	(3.4 +/- 0.4)E-05						
IM C3 2/4	V4795	(1.6 +/- 0.6)E-05	(9.1 +/- 2.7)E-06	4 +/- 2	2.0 +/- 0.6	1.2 +/- 0.3	0.6 +/- 0.3	0.005 +/- 0.08	-0.05 +/- 0.08
IM C3 6/8	V4796	(2.0 +/- 0.6)E-05	(1.8 +/- 0.3)E-05	10 +/- 2	1.8 +/- 0.3	0.9 +/- 0.2	1.1 +/- 0.2	0.04 +/- 0.06	0.04 +/- 0.06
IM C3 9/11	V4797	(1.5 +/- 0.5)E-05	(2.3 +/- 0.4)E-05	15 +/- 3	2.1 +/- 0.5	0.7 +/- 0.4	0.9 +/- 0.3	0.08 +/- 0.1	-0.08 +/- 0.1
IM D1 2/4	V4798	(1.6 +/- 0.5)E-05	(1.3 +/- 0.3)E-05	3 +/- 1	2.1 +/- 0.4	1.2 +/- 0.3	1.3 +/- 0.2	0.01 +/- 0.05	-0.01 +/- 0.06
IM D1 6/8	V4799	(2.0 +/- 0.6)E-05	(2.3 +/- 0.4)E-05	12 +/- 2	2.1 +/- 0.4	1.1 +/- 0.2	1.2 +/- 0.2	-0.007 +/- 0.06	0.01 +/- 0.06
IM D1 9/11	V4800	(2.2 +/- 0.6)E-05	(3.0 +/- 0.4)E-05	27 +/- 4	3.0 +/- 0.6	1.5 +/- 0.4	1.3 +/- 0.3	0.1 +/- 0.1	-0.06 +/- 0.1
IM D2 2/4	V4801	(2.3 +/- 0.6)E-05	(9.4 +/- 3.0)E-06	3 +/- 1	2.3 +/- 0.4	1.3 +/- 0.2	1.3 +/- 0.3	-0.002 +/- 0.05	0.03 +/- 0.06
IM D2 6/8	V4802	(9.9 +/- 4.6)E-06	(6.8 +/- 2.8)E-06	3 +/- 2	1.0 +/- 0.5	0.5 +/- 0.3	0.7 +/- 0.4	0.02 +/- 0.09	0.03 +/- 0.09
IM D2 9/11	V4803	(2.1 +/- 0.6)E-05	(2.3 +/- 0.4)E-05	16 +/- 2	1.3 +/- 0.3	1.0 +/- 0.2	1.2 +/- 0.3	0.006 +/- 0.07	-0.01 +/- 0.06
IM D2 9/11 DUP	V4803	(1.6 +/- 0.6)E-05	(2.3 +/- 0.4)E-05						
IM D3 2/4	V4804	(1.9 +/- 0.6)E-05	(8.7 +/- 2.8)E-06	6 +/- 2	2.1 +/- 0.7	0.6 +/- 0.3	1.1 +/- 0.3	-0.04 +/- 0.1	0.04 +/- 0.09
IM D3 6/8	V4805	(1.1 +/- 0.5)E-05	(1.3 +/- 0.3)E-05	6 +/- 1	1.6 +/- 0.4	1.0 +/- 0.3	0.8 +/- 0.2	0.0003 +/- 0.06	-0.05 +/- 0.05
IM D3 9/1 1	V4806	(2.2 +/- 0.6)E-05	(2.6 +/- 0.4)E-05	21 +/- 4	2.0 +/- 0.7	1.2 +/- 0.4	1.2 +/- 0.4	-0.1 +/- 0.1	-0.07 +/- 0.09
IM E1 2/4	V4807	(2.2 +/- 0.6)E-05	(7.7 +/- 2.9)E-06	2 +/- 1	1.8 +/- 0.4	1.2 +/- 0.2	1.3 +/- 0.2	-0.007 +/- 0.05	-0.02 +/- 0.06
IM E1 6/8	V4808	(2.5 +/- 0.7)E-05	(1.5 +/- 0.3)E-05	9 +/- 3	2.2 +/- 0.8	1.2 +/- 0.4	1.4 +/- 0.3	0.002 +/- 0.1	-0.04 +/- 0.09
IM E1 9/11	V4809	(2.1 +/- 0.6)E-05	(3.0 +/- 0.4)E-05	23 +/- 2	1.7 +/- 0.5	1.2 +/- 0.3	1.4 +/- 0.3	0.02 +/- 0.07	-0.03 +/- 0.06
IM E2 2/4	V4810	(9.1 +/- 4.5)E-06	(9.8 +/- 3.0)E-06	5 +/- 1	1.7 +/- 0.5	0.8 +/- 0.2	1.1 +/- 0.3	0.03 +/- 0.05	0.05 +/- 0.06
IM E2 6/8	V4811	(2.1 +/- 0.6)E-05	(8.1 +/- 2.9)E-06	3 +/- 2	1.8 +/- 0.5	0.8 +/- 0.3	1.2 +/- 0.3	0.09 +/- 0.1	0.03 +/- 0.09
IM E2 9/11	V4812	(2.0 +/- 0.6)E-05	(1.9 +/- 0.4)E-05	13 +/- 2	2.0 +/- 0.4	1.1 +/- 0.2	1.2 +/- 0.2	0.06 +/- 0.06	-0.0007 +/- 0.06

TABLE F-3. Iron Mountain Laboratory Results (Continued)

		Microcuries per Gram		Picocuries per Gram					
Sample	Lab	+/- 2 Standard Deviations		+/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
IM E3 2/4	V4813	(2.1 +/- 0.6)E-05	(8.2 +/- 2.9)E-06	3 +/- 2	1.6 +/- 0.6	0.7 +/- 0.3	0.9 +/- 0.3	-0.05 +/- 0.1	-0.03 +/- 0.08
IM E3 6/8	V4814	(1.4 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	2 +/- 1	1.7 +/- 0.3	0.8 +/- 0.2	0.9 +/- 0.2	-0.0003 +/- 0.05	-0.07 +/- 0.05
IM E3 9/11	V4815	(1.6 +/- 0.6)E-05	(6.9 +/- 2.8)E-06	4 +/- 2	1.6 +/- 0.5	0.8 +/- 0.3	0.6 +/- 0.3	0.02 +/- 0.1	-0.05 +/- 0.08
IM E1-2 9/11 Hot Spot	V4816	(2.1 +/- 0.6)E-05	(2.9 +/- 0.4)E-05	29 +/- 2	2.5 +/- 0.4	1.2 +/- 0.2	1.7 +/- 0.3	-0.009 +/- 0.07	-0.01 +/- 0.07
IM E1-2 9/11 Hot Spot DUP	V4816	(2.3 +/- 0.6)E-05	(3.2 +/- 0.4)E-05						
IM E2-4 6/8 Hot Spot	V4817	(2.4 +/- 0.7)E-05	(1.1 +/- 0.3)E-05	3 +/- 1	2.6 +/- 0.5	1.1 +/- 0.2	1.2 +/- 0.2	-0.009 +/- 0.05	-0.03 +/- 0.06

TABLE F-4. Rattlesnake Gulch Laboratory Results

		Microcuries per Gram		Picocuries per Gram					
Sample	Lab	+/- 2 Standard Deviations		+/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
RG BKG A1-1 2/4	V4680	(3.4 +/- 0.8)E-05	(1.3 +/- 0.3)E-05	4 +/- 2	3.0 +/- 0.7	1.7 +/- 0.4	2.2 +/- 0.3	0.008 +/- 0.1	-0.1 +/- 0.09
RG BKG A1-2 2/4	V4681	(1.1 +/- 0.5)E-05	(6.7 +/- 2.7)E-06	1 +/- 1	1.2 +/- 0.3	0.8 +/- 0.2	0.6 +/- 0.2	-0.02 +/- 0.05	-0.02 +/- 0.06
RG BKG A1-3 2/4	V4682	(8.7 +/- 4.5)E-06	(6.0 +/- 2.6)E-06	3 +/- 1	1.2 +/- 0.5	0.5 +/- 0.2	0.7 +/- 0.2	-0.03 +/- 0.1	0.01 +/- 0.08
RG BKG A1-4 2/4	V4683	(2.3 +/- 0.7)E-05	(1.5 +/- 0.3)E-05	4 +/- 1	2.9 +/- 0.5	1.6 +/- 0.2	1.4 +/- 0.3	-0.002 +/- 0.05	0.02 +/- 0.06
RG BKG A1-5 2/4	V4684	(1.8 +/- 0.6)E-05	(1.0 +/- 0.3)E-05	5 +/-2	1.6 +/- 0.5	1.0 +/- 0.4	0.9 +/- 0.3	0.03 +/- 0.09	-0.01 +/- 0.09
RG BKG A1-1 6/8	V4685	(3.0 +/- 0.7)E-05	(1.4 +/- 0.3)E-05	3 +/- 1	2.1 +/- 0.4	1.3 +/- 0.3	1.5 +/- 0.3	0.02 +/- 0.05	-0.03 +/- 0.06
RG BKG A1-4 6/8	V4686	(3.4 +/- 0.8)E-05	(2.0 +/- 0.4)E-05	3 +/- 2	2.9 +/- 0.6	1.7 +/- 0.4	1.8 +/- 0.4	0.05 +/- 0.09	-0.004 +/- 0.1
RG BKG A1-1 10/12	V4687	(3.5 +/- 0.8)E-05	(2.0 +/- 0.4)E-05	6 +/- 1	2.3 +/- 0.5	1.7 +/- 0.3	1.7 +/- 0.2	0.002 +/- 0.05	-0.03 +/- 0.06
RG BKG A1-4 10/12	V4688	(2.6 +/- 0.7)E-05	(1.7 +/- 0.3)E-05	5 +/- 2	2.7 +/- 0.6	1.2 +/- 0.4	1.7 +/- 0.4	0.03 +/- 0.09	-0.005 +/- 0.1
RG BKG A1-4 10/12 DUP	V4688	(2.7 +/- 0.7)E-05	(2.0 +/- 0.4)E-05						
RG BKG A2-1 2/4	V4689	(7.9 +/- 4.4)E-06	(5.7 +/- 2.6)E-06	2 +/- 1	1.0 +/- 0.4	0.5 +/- 0.2	0.7 +/- 0.3	-0.02 +/- 0.06	0.09 +/- 0.07
RG BKG A2-2 2/4	V4690	(9.1 +/- 4.6)E-06	(7.3 +/- 2.7)E-06	5 +/- 2	1.3 +/- 0.7	0.5 +/- 0.5	0.9 +/- 0.4	-0.08 +/- 0.1	0.1 +/- 0.1
RG BKG A2-3 2/4	V4691	(1.4 +/- 0.5)E-05	(4.1 +/- 2.4)E-06	1 +/- 1	0.9 +/- 0.3	0.5 +/- 0.2	0.7 +/- 0.1	0.05 +/- 0.04	-0.02 +/- 0.05
RG BKG A2-4 2/4	V4692	(2.2 +/- 0.6)E-05	(1.2 +/- 0.3)E-05	3 +/- 1	2.4 +/- 0.6	1.1 +/- 0.3	1.2 +/- 0.3	0.02 +/- 0.1	-0.02 +/- 0.1
RG BKG A2-5 2/4	V4693	(1.4 +/- 0.5)E-05	(8.9 +/- 2.8)E-06	1 +/- 1	1.6 +/- 0.3	0.8 +/- 0.2	0.9 +/- 0.2	0.01 +/- 0.05	-0.03 +/- 0.05
RG BKG A2-4 6/8	V4694	(9.5 +/- 4.7)E-06	(5.6 +/- 2.6)E-06	3 +/- 1	0.8 +/- 0.5	0.6 +/- 0.2	0.5 +/- 0.3	0.05 +/- 0.1	0.02 +/- 0.06
RG BKG A2-5 6/8	V4695	(2.6 +/- 0.7)E-05	(1.2 +/- 0.3)E-05	1.1 +/- 0.6	2.8 +/- 0.5	1.4 +/- 0.3	1.7 +/- 0.3	-0.02 +/- 0.06	0.02 +/- 0.06
RG BKG A2-4 9/11	V4696	(8.7 +/- 4.5)E-06	(6.6 +/- 2.7)E-06	0.6 +/- 1.2	1.4 +/- 0.7	0.5 +/- 0.3	0.8 +/- 0.3	-0.007 +/- 0.09	-0.003 +/- 0.08
RG A1 2/4	V4697	(2.1 +/- 0.6)E-05	(1.4 +/- 0.3)E-05	7 +/- 2	1.3 +/- 0.4	1.4 +/- 0.3	1.2 +/- 0.3	0.01 +/- 0.1	-0.01 +/- 0.08
RG A1 2/4 DUP	V4697	(1.8 +/- 0.6)E-05	(1.2 +/- 0.3)E-05						
RG A1 6/8	V4698	(2.9 +/- 0.7)E-05	(1.2 +/- 0.3)E-05	4 +/- 1	2.0 +/- 0.4	1.6 +/- 0.3	1.6 +/- 0.3	0.04 +/- 0.05	-0.05 +/- 0.06
RG A1 10/12	V4699	(3.2 +/- 0.7)E-05	(1.9 +/- 0.4)E-05	5 +/- 5	3.0 +/- 0.4	1.7 +/- 0.3	1.9 +/- 0.3	-0.01 +/- 0.05	-0.04 +/- 0.07
RG A2 2/4	V4700	(2.0 +/- 0.6)E-05	(1.4 +/- 0.3)E-05	8 +/- 2	1.1 +/- 0.4	1.2 +/- 0.3	1.4 +/- 0.4	0.04 +/- 0.1	-0.005 +/- 0.08
RG A2 6/8	V4701	(2.3 +/- 0.6)E-05	(2.0 +/- 0.4)E-05	12 +/- 2	1.0 +/- 0.4	1.8 +/- 0.3	1.9 +/- 0.3	-0.06 +/- 0.06	-0.1 +/- 0.06

TABLE F-4. Rattlesnake Gulch Laboratory Results (Continued)

		Microcuries per Gram		Picocuries per Gram					
Sample	Lab	+/- 2 Standard Deviations		+/- 2 Standard Deviations					
Identification	Number	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
RG A2 10/12	V4702	(2.3 +/- 0.6)E-05	(1.8 +/- 0.3)E-05	6 +/- 2	2.2 +/- 0.5	1.5 +/- 0.5	1.4 +/- 0.3	-0.001 +/- 0.1	0.05 +/- 0.08
RG A3 2/4	V4703	(1.3 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	5 +/- 1	0.3 +/- 0.2	1.3 +/- 0.2	1.3 +/- 0.3	-0.002 +/- 0.05	-0.005 +/- 0.05
RG A3 6/8	V4704	(1.6 +/- 0.5)E-05	(9.3 +/- 2.9)E-06	6 +/- 2	1.0 +/- 0.4	1.1 +/- 0.3	0.9 +/- 0.3	-0.07 +/- 0.1	-0.01 +/- 0.08
RG A3 10/12	V4705	(3.5 +/- 0.8)E-05	(2.3 +/- 0.4)E-05	13 +/- 2	1.2 +/- 0.4	2.1 +/- 0.3	2.2 +/- 0.3	0.009 +/- 0.07	-0.06 +/- 0.06
RG B1 2/4	V4706	(2.3 +/- 0.6)E-05	(1.3 +/- 0.3)E-05	7 +/- 2	1.6 +/- 0.5	0.7 +/- 0.3	0.7 +/- 0.3	0.01 +/- 0.1	-0.05 +/- 0.09
RG B1 2/4 DUP	V4706	(1.9 +/- 0.6)E-05	(1.1 +/- 0.3)E-05						
RG B1 6/8	V4707	(1.7 +/- 0.5)E-05	(1.5 +/- 0.3)E-05	9 +/- 1	1.4 +/- 0.4	0.8 +/- 0.2	0.7 +/- 0.2	0.03 +/- 0.05	0.02 +/- 0.05
RG B1 10/12	V4708	(2.1 +/- 0.6)E-05	(1.3 +/- 0.3)E-05	5 +/- 2	2.0 +/- 0.7	0.8 +/- 0.3	1.0 +/- 0.3	-0.02 +/- 0.1	-0.05 +/- 0.09
RG B2 2/4	V4709	(2.0 +/- 0.6)E-05	(9.8 +/- 3.0)E-06	5 +/- 1	1.9 +/- 0.4	1.0 +/- 0.2	1.3 +/- 0.3	-0.02 +/- 0.06	-0.02 +/- 0.06
RG B2 6/8	V4710	(1.9 +/- 0.6)E-05	(1.0 +/- 0.3)E-05	7 +/- 1	1.3 +/- 0.3	0.9 +/- 0.2	0.9 +/- 0.2	0.009 +/- 0.05	0.04 +/- 0.05
RG B2 10/12	V4711	(4.5 +/- 0.8)E-05	(2.2 +/- 0.4)E-05	8 +/- 2	2.9 +/- 0.7	1.2 +/- 0.4	1.3 +/- 0.4	-0.003 +/- 0.1	-0.02 +/- 0.1
RG B3 2/4	V4712	(2.5 +/- 0.6)E-05	(1.5 +/- 0.3)E-05	7 +/- 1	1.6 +/- 0.3	1.4 +/- 0.3	1.5 +/- 0.2	0.01 +/- 0.05	-0.01 +/- 0.05
RG B3 6/8	V4713	(1.7 +/- 0.5)E-05	(1.3 +/- 0.3)E-05	6 +/- 2	1.7 +/- 0.5	1.1 +/- 0.4	1.1 +/- 0.3	-0.008 +/- 0.1	0.04 +/- 0.08
RG B3 10/12	V4714	(2.5 +/- 0.6)E-05	(1.6 +/- 0.3)E-05	7 +/- 1	1.3 +/- 0.3	1.2 +/- 0.2	1.4 +/- 0.2	-0.009 +/- 0.05	-0.01 +/- 0.06
RG C1 2/4	V4715	(3.2 +/- 0.7)E-05	(1.6 +/- 0.3)E-05	5 +/- 2	2.8 +/- 0.7	1.1 +/- 0.3	1.3 +/- 0.4	0.07 +/- 0.1	0.04 +/- 0.09
RG C1 2/4 DUP	V4715	(3.1 +/- 0.7)E-05	(1.4 +/- 0.3)E-05						
RG C1 6/8	V4716	(2.3 +/- 0.6)E-05	(6.2 +/- 2.7)E-06	2 +/- 1	1.9 +/- 0.4	0.8 +/- 0.2	0.7 +/- 0.2	0.03 +/- 0.05	-0.01 +/- 0.05
RG C2 2/4	V4717	(7.1 +/- 3.8)E-06	(5.4 +/- 2.5)E-06	5 +/- 2	0.8 +/- 0.4	0.3 +/- 0.2	0.3 +/- 0.2	0.05 +/- 0.09	0.02 +/- 0.09
RG C2 6/8	V4718	(1.4 +/- 0.5)E-05	(7.9 +/- 2.7)E-06	3 +/- 1	1.4 +/- 0.3	0.6 +/- 0.2	0.8 +/- 0.2	0.04 +/- 0.05	0.04 +/- 0.05
RG C2 10/12	V4719	(2.7 +/- 0.7)E-05	(1.4 +/- 0.3)E-05	2 +/- 2	2.5 +/- 0.7	0.8 +/- 0.3	0.7 +/- 0.3	-0.03 +/- 0.1	0.07 +/- 0.09
RG C3 2/4	V4720	(8.4 +/- 4.7)E-06	(4.8 +/- 2.6)E-06	3 +/- 2	1.1 +/- 0.4	0.6 +/- 0.3	0.6 +/- 0.3	-0.05 +/- 0.1	-0.03 +/- 0.08
RG C3 6/8	V4721	(1.9 +/- 0.6)E-05	(8.8 +/- 2.9)E-06	6 +/- 1	2.0 +/- 0.4	0.8 +/- 0.2	0.8 +/- 0.2	0.05 +/- 0.05	0.01 +/- 0.06
RG C3 10/12	V4722	(6.0 +/- 4.2)E-06	(4.8 +/- 2.6)E-06	3 +/- 2	1.3 +/- 0.4	0.5 +/- 0.2	0.6 +/- 0.3	-0.001 +/- 0.1	0.09 +/- 0.1
RG C3 10/12 DUP	V4722	(4.4 +/- 3.9)E-06	(5.1 +/- 2.6)E-06						
RG D1 2/4	V4723	(2.2 +/- 0.6)E-05	(1.1 +/- 0.3)E-05	3 +/- 1	2.5 +/- 0.4	1.0 +/- 0.2	1.3 +/- 0.3	0.03 +/- 0.06	-0.03 +/- 0.06
RG D1 6/8	V4724	(1.8 +/- 0.6)E-05	(1.0 +/- 0.3)E-05	2 +/- 2	1.7 +/- 0.6	0.4 +/- 0.4	0.7 +/- 0.3	-0.005 +/- 0.07	-0.06 +/- 0.1

TABLE F-4. Rattlesnake Gulch Laboratory Results (Continued)

Sample Identification	Lab Number	Microcuries per Gram +/- 2 Standard Deviations		Picocuries per Gram +/- 2 Standard Deviations					
		Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	Co-60	Cs-137
RG D1 10/12	V4725	(1.3 +/- 0.5)E-05	(7.9 +/- 2.8)E-06	1 +/- 1	1.7 +/- 0.4	0.8 +/- 0.2	0.9 +/- 0.2	0.003 +/- 0.05	-0.03 +/- 0.05
RG D2 2/4	V4726	(3.1 +/- 0.7)E-05	(9.6 +/- 3.0)E-06	4 +/- 1	2.9 +/- 0.7	1.2 +/- 0.3	1.1 +/- 0.4	0.05 +/- 0.1	0.02 +/- 0.09
RG D3 2/4	V4727	(1.2 +/- 0.5)E-05	(7.4 +/- 2.8)E-06	3 +/- 1	1.5 +/- 0.3	0.4 +/- 0.2	0.5 +/- 0.3	0.004 +/- 0.05	0.02 +/- 0.06
RG D3 6/8	V4728	(1.3 +/- 0.5)E-05	(6.4 +/- 2.7)E-06	3 +/- 2	1.8 +/- 0.5	0.4 +/- 0.3	0.5 +/- 0.2	0.03 +/- 0.07	0.003 +/- 0.1
RG D3 10/12	V4729	(2.1 +/- 0.6)E-05	(7.8 +/- 2.9)E-06	3 +/- 1	2.0 +/- 0.4	0.8 +/- 0.2	0.8 +/- 0.2	0.04 +/- 0.05	0.007 +/- 0.05
RG E1 2/4	V4730	(2.5 +/- 0.7)E-05	(1.1 +/- 0.3)E-05	2 +/- 1	2.5 +/- 0.4	0.9 +/- 0.2	1.0 +/- 0.2	0.03 +/- 0.05	0.01 +/- 0.06
RG E1 6/8	V4731	(1.4 +/- 0.5)E-05	(8.8 +/- 2.9)E-06	3 +/- 1	1.3 +/- 0.5	0.7 +/- 0.4	0.6 +/- 0.3	-0.02 +/- 0.1	0.01 +/- 0.09
RG E2 +2/0	V4732	(1.7 +/- 0.6)E-05	(1.1 +/- 0.3)E-05	2 +/- 1	0.9 +/- 0.3	1.0 +/- 0.2	1.2 +/- 0.2	0.02 +/- 0.06	0.2 +/- 0.08
RG E2 2/4	V4733	(2.7 +/- 0.7)E-05	(1.1 +/- 0.3)E-05	4 +/- 1	1.9 +/- 0.7	0.6 +/- 0.4	1.0 +/- 0.3	0.04 +/- 0.1	-0.02 +/- 0.09
RG E2 6/8	V4734	(2.5 +/- 0.7)E-05	(1.0 +/- 0.3)E-05	3 +/- 1	2.1 +/- 0.4	1.0 +/- 0.2	1.2 +/- 0.3	-0.02 +/- 0.06	0.03 +/- 0.06
RG E2 10/12	V4735	(1.8 +/- 0.6)E-05	(6.4 +/- 2.8)E-06	3 +/- 1	1.4 +/- 0.5	0.7 +/- 0.3	0.7 +/- 0.3	0.03 +/- 0.06	0.003 +/- 0.07
RG E2 10/12 DUP	V4735	(1.9 +/- 0.6)E-05	(6.6 +/- 2.8)E-06						
RG E3 2/4	V4736	(1.2 +/- 0.5)E-05	(7.8 +/- 2.9)E-06	2 +/- 1	1.7 +/- 0.3	0.5 +/- 0.2	0.8 +/- 0.2	0.008 +/- 0.04	-0.02 +/- 0.05
RG E3 6/8	V4737	(1.3 +/- 0.5)E-05	(9.4 +/- 2.9)E-06	3 +/- 2	3.1 +/- 0.6	0.9 +/- 0.3	1.0 +/- 0.4	0.04 +/- 0.08	0.01 +/- 0.09
RG E3 10/12	V4738	(4.8 +/- 4.0)E-06	(6.4 +/- 2.7)E-06	3 +/- 1	1.3 +/- 0.3	0.4 +/- 0.2	0.8 +/- 0.2	0.03 +/- 0.04	0.009 +/- 0.05
RG RANDOM-1 2/4	V4739	(1.4 +/- 0.5)E-05	(1.4 +/- 0.3)E-05	3 +/- 1	0.6 +/- 0.3	2.1 +/- 0.3	2.2 +/- 0.3	0.03 +/- 0.05	-0.04 +/- 0.06
RG RANDOM 2 2/4	V4740	(1.3 +/- 0.5)E-05	(1.1 +/- 0.3)E-05	7 +/- 2	1.3 +/- 0.4	0.5 +/- 0.3	0.8 +/- 0.3	0.08 +/- 0.1	-0.02 +/- 0.09
RG RANDOM 2 6/8	V4741	(9.9 +/- 4.5)E-06	(8.6 +/- 2.8)E-06	4 +/- 1	0.3 +/- 0.2	1.0 +/- 0.2	1.0 +/- 0.2	0.006 +/- 0.05	-0.006 +/- 0.05
RG RANDOM 2 6/8 DUP	V4741	(1.2 +/- 0.5)E-05	(8.6 +/- 2.8)E-06						

TABLE F-5. Iron Mountain Down-Hole Logging Results

Iron Mountain Background Area						
Grid Location	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
IM BKG A1-1	1640.6	2207.2	2586.6	2923.6		
IM BKG A1-2	1641.2	2089	2373	2104.6	2363.6	3144.6
IM BKG A1-3	1736.6	2136.4	2187.8	2556.8	2944.4	2925.2
IM BKG A1-4						
IM BKG A1-5	1648.2	2025.4	2227.8	2428	2650.2	2238.2
IM BKG A2-1	1442					
IM BKG A2-2	1918.6	1594.2				
IM BKG A2-3	1453.4					
IM BKG A2-4						
IM BKG A2-5	1410.2	1595.4	1883.8			
Iron Mountain Survey Unit						
Grid Location	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
IM A1-1	861.6	926.4				
IM A1-2						
IM A1-3	889.6					
IM A1-4	1396	1260.4	2216.4	2477.2	2258	2569
IM A1-5	965.2					
IM A2-1	517.2					
IM A2-2	1036	1394.4	1607.6			
IM A2-3	799.2	1042.4				
IM A2-4						
IM A2-5	840					

TABLE F-5. Iron Mountain Down-Hole Logging Results (Continued)

Grid Location	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
IM A3-1	607.2					
IM A3-2	1168	1147.6	1103.6	983.2		
IM A3-3	1270	1654.4	1626.8	1652.8		
IM A3-4	1514.4	1761.2	1858	1760.4	1937.6	
IM A3-5	1851.6	2020	1240	2039.2	1979.6	
IM B1-1	1386.8	2259.6	2437.2	2466.4	2388.8	2706.6
IM B1-2	1533	2099	2248.4			
IM B1-3	1730.6	2098.4	2161.6	2200.8	2752.4	
IM B1-4	1710.4	2263.6	2434.2	2691	2686.2	2731
IM B1-5	1287.4	2244				
IM B2-1						
IM B2-2	1297.2	1642.8				
IM B2-3	1218.4					
IM B2-4	1223.6	1267.2	1724.8	2228	2409.6	
IM B2-5	1421.6	1674.4	1764	1612.8	1704.4	
IM B3-1	1681.6	1826.8	1498	1371.6	1182	
IM B3-2	1327.2	1116	971.2	1488	1549.2	
IM B3-3	1689.2	1578.4	1170.4	1481.2	1456.4	
IM B3-4	1587.6	1638	1456.4	1205.6	1254.8	
IM B3-5	1402	1044.4	2278.8	1619.6		
IM C1-1	1432	1978.6	2330.8	2585.4	2403	2450.8
IM C1-2	1185.8	2111.4				
IM C1-3	1307.2	1807.4	2152.2	2231	1458.8	2507
IM C1-4	838.2	944.4	1570.6	1657.4	2562.6	2158.6

TABLE F-5. Iron Mountain Down-Hole Logging Results (Continued)

Grid Location	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
IM C1-5	1058.4	1342.6	2139.6	2283	2412.8	1963.4
IM C2-1	1238	1458	1216.8	2172	1736.8	2376
IM C2-2	1378.8	1357.6	1284	1354.4		
IM C2-3	1204	1199.2	1304.4			
IM C2-4	1283.6	1688	1190.8			
IM C2-5	1150	1494.4	1379.2	1533.2		
IM C3-1	1244.4	1462.4	1315.6	1309.2		
IM C3-2	1455.6	1400.4	1120.4	1201.6		
IM C3-3	1146	1454	1224.8	1236.8	1302.4	
IM C3-4	1133.2	1361.6				
IM C3-5	1292.4	1502.4	1285.6	1200.8	796.4	
IM D1-1	954.8	809.4				
IM D1-2	932.4	1119.4	1692.2	2241.8	2437.8	
IM D1-3	1123.4	1311	1243	1476.8	2230.4	2587
IM D1-4	1175.8	1371.8	1352.6	1183.4	1305.6	
IM D1-5	1264.6	1437.6	1436.6	1721.8	2271.4	
IM D2-1	1078	1508	1245.6			
IM D2-2	1224.4	1518	1383.6			
IM D2-3	1144.4	1271.2				
IM D2-4						
IM D2-5	1132.4	1508.8	1233.6			
IM D3-1	1117.2	1415.2	1496	1338.4		
IM D3-2	1355.2	1224.4	1346.8	2366.4	2486.8	2462.8
IM D3-3	1038.8	1470	1346.4		989.6	

TABLE F-5. Iron Mountain Down-Hole Logging Results (Continued)

Grid Location	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
IM D3-4	1154.4	1357.2	1175.2	1258.4		
IM D3-5	1344.4	1618.8	1274.4	1116.8	2196	2146
IM E1-1	1179.8	1268.2	1358.4	1283.8	1742.8	
IM E1-2	1165.2	1276	1340.8	1665.2	2228.4	
IM E1-3	1137.2					
IM E1-4	1163.2	1196.2	1163.4	1758.4	2266.2	2294
IM E1-5	1189.2	1231.6	1265.6	2099.6	2196.8	
IM E2-1	1094	1225.6	1493.2	1504.4	1510	
IM E2-2	1099.2	1323.6				
IM E2-3	1172.8	1307.6				
IM E2-4	1167.2	1318.4	1621.2	1736.8	1611.2	
IM E2-5	1197.6	1315.2	1114.4	1525.6		
IM E3-1	1138	1600.4	1265.6	1153.6	1187.6	
IM E3-2	1617.6	1562.8	1073.2	1107.6		
IM E3-3	1150	1356	1335.2	1391.6		
IM E3-4	1181.6	1530.8				
IM E3-5	1327.2	1446.4	1351.6	1364.8	1022.4	1187.2

APPENDIX G

Statistical Data and Test Results

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis

Descriptive Statistics:

IM Background Area	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
Mean	1611.35	1941.26666667	2251.8	2503.25	2652.7333333	2769.3333333
Standard Error	60.8398923405	112.217071389	115.51547083	169.348287561	167.66730285	273.01468418
Median	1640.9	2057.2	2227.8	2492.4	2650.2	2925.2
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	172.081201762	274.874565332	258.30044522	338.696575123	290.4082873	472.87530421
Sample Variance	29611.94	75556.0266667	66719.12	114715.37	84336.973333	223611.05333
Kurtosis	-0.112818577824	-1.86058591327	0.7435029041	0.815829545055	#DIV/0!	#DIV/0!
Skewness	0.528386054276	-0.76736184472	-0.261204208	0.182679149996	0.0392520909	-1.322115535
Range	508.4	613	702.8	819	580.8	906.4
Minimum	1410.2	1594.2	1883.8	2104.6	2363.6	2238.2
Maximum	1918.6	2207.2	2586.6	2923.6	2944.4	3144.6
Sum	12890.8	11647.6	11259	10013	7958.2	8308
Count	8	6	5	4	3	3
Confidence Level(95.000%)	119.24382124	219.941092694	226.40582722	331.916052978	328.62138836	535.09815589

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

IM Survey Unit	cpm 1 ft	cpm 3 ft	cpm 5 ft	cpm 7 ft	cpm 9 ft	cpm 11 ft
Mean	1219.43943662	1475.334375	1507.9396226	1674.17333333	1879.8470588	2318.4153846
Standard Error	29.0373867435	40.6272835878	53.896883103	68.8824522376	94.525089732	113.07601133
Median	1185.8	1426.4	1351.6	1533.2	1958.6	2450.8
Mode	1327.2	#N/A	1265.6	#N/A	#N/A	#N/A
Standard Deviation	244.673369722	325.018268702	392.37523168	462.07753698	551.17125108	407.70135689
Sample Variance	59865.0578511	105636.87499	153958.32244	213515.650182	303789.74802	166220.39641
Kurtosis	1.02595837621	0.434967487172	0.1713767015	-0.767006026155	-1.183197039	4.6449526852
Skewness	0.00685134652368	0.733442023999	1.1401666856	0.626053604255	-0.263819758	-1.9262353
Range	1334.4	1454.2	1466	1707.8	1956	1543.8
Minimum	517.2	809.4	971.2	983.2	796.4	1187.2
Maximum	1851.6	2263.6	2437.2	2691	2752.4	2731
Sum	86580.2	94421.4	79920.8	75337.8	63914.8	30139.4
Count	71	64	53	45	34	13
Confidence Level(95.000%)	56.9121479495	79.6278947124	105.63579334	135.00692564	185.26549718	221.62458156

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

Data Used for Linear Least Squares Regression:

Depth (ft)	Background Area (BA) Mean (cpm)	Survey Unit (SU) Mean (cpm)
1	1611.4	1219.4
3	1941.3	1475.3
5	2251.8	1507.9
7	2503.2	1674.2
9	2652.7	1879.8
11	2769.3	2318.4

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

Regression Statistics Iron Mountain Background Area:

SUMMARY OUTPUT BACKGROUND AREA								
Regression Statistics								
Multiple R	0.981898773636							
R Square	0.964125201669							
Adjusted R Square	0.955156502086							
Standard Error	94.2491602281							
Observations	6							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	1	954902.294	954902.29	107.498884623	0.0005			
Residual	4	35531.6168	8882.9042					
Total	5	990433.911						
	Coefficients	Std Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	1587.50888889	77.7742552	20.411753	0.000034	1371.5725	1803.4453	1371.57249	1803.44529
Depth (ft)	116.796666667	11.264929	10.368169	0.00048852	85.520144	148.07319	85.5201442	148.073189

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

RESIDUAL OUTPUT				PROBABILITY OUTPUT				
Observation	Predicted Mean (cpm)	Residuals		Percentile	Mean (cpm)			
1	1704.30555556	-92.955556		8.33333333333	1611.35			
2	1937.89888889	3.36777778		25	1941.2667			
3	2171.49222222	80.3077778		41.6666666667	2251.8			
4	2405.08555556	98.1644444		58.3333333333	2503.25			
5	2638.67888889	14.0544444		75	2652.7333			
6	2872.27222222	-102.93889		91.6666666667	2769.3333			

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

Regression Statistics Iron Mountain Survey Unit:

SUMMARY OUTPUT SURVEY UNIT								
Regression Statistics								
Multiple R	0.960943514553							
R Square	0.923412438162							
Adjusted R Square	0.904265547702							
Standard Error	118.318575842							
Observations	6							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	1	675154.761	675154.76	48.2278017996	0.00226			
Residual	4	55997.1416	13999.285					
Total	5	731151.903						
	Coefficients	Std Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	1089.93569213	97.6362982	11.163222	0.00036653	818.85331	1361.0181	818.853309	1361.01808
Depth (ft)	98.2093071734	14.1417747	6.9446239	0.00225832502465	58.945365	137.4732	58.9453647	137.47325

Table G-1. Iron Mountain Down-Hole Descriptive Statistics and Linear Regression Analysis (Continued)

RESIDUAL OUTPUT				PROBABILITY OUTPUT				
Observation	Predicted Mean (cpm)	Residuals		Percentile	Mean (cpm)			
1	1188.14499931	31.2944373		8.33333333333	1219.4394			
2	1384.56361365	90.7707613		25	1475.334			
3	1580.982228	-73.042605		41.6666666667	1507.9396			
4	1777.40084235	-103.22751		58.3333333333	1674.1733			
5	1973.81945669	-93.972398		75	1879.8471			
6	2170.23807104	148.177314		91.6666666667	2318.4154			

Figure G-1. Iron Mountain Linear Regression Plots of Down-Hole Data

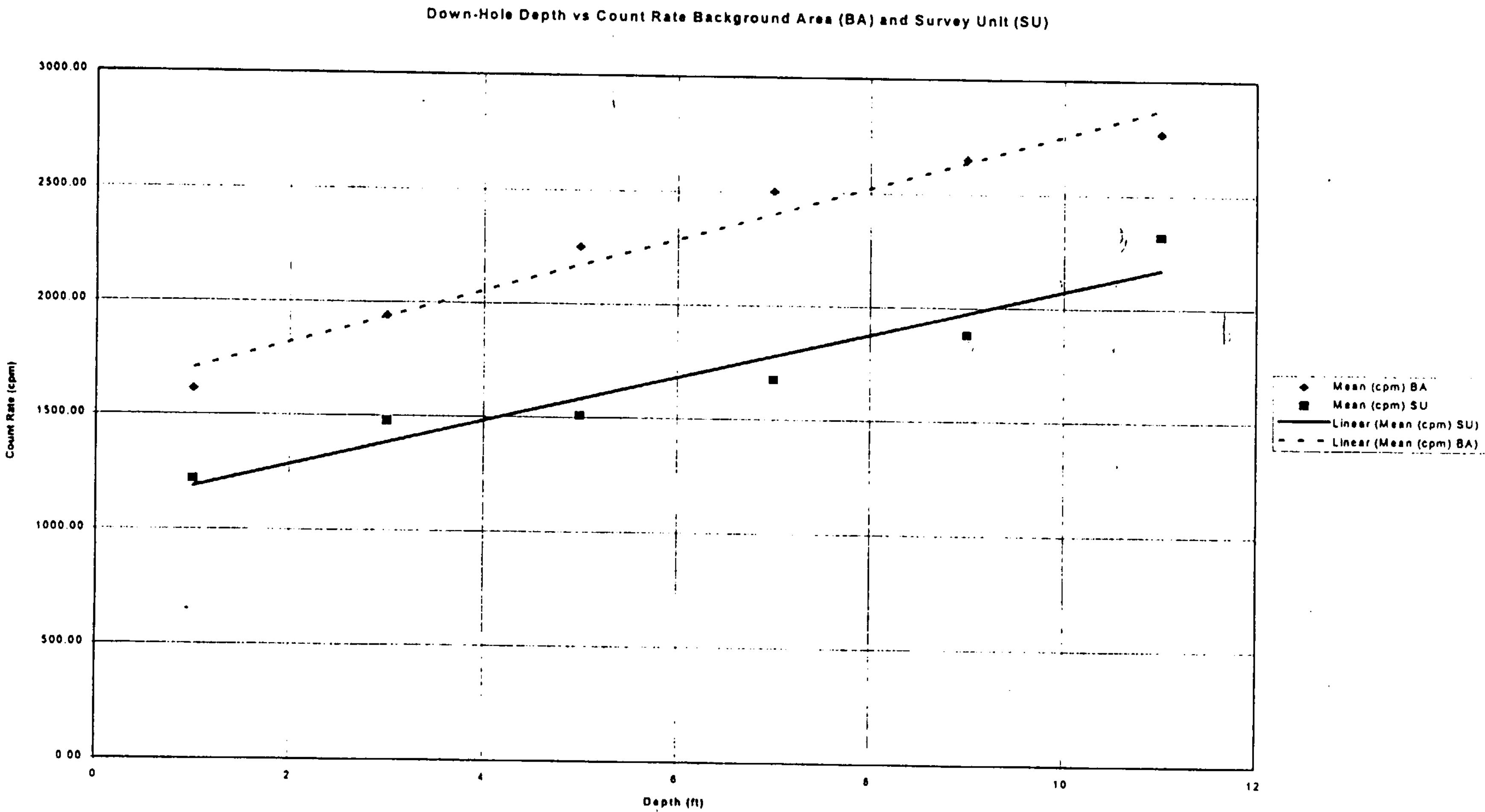


Table G-2. Iron Mountain Laboratory Results Statistical Data Summary

Iron Mountain Background Area					
			95% Confidence		
	Mean	Std Dev. (s)	(1.96*s)	Low Limit	High Limit
Gross Alpha	25.93	5.41	10.60	15.33	36.53
Gross Beta	29.39	12.05	23.62	5.77	53.02
K-40	21.86	13.13	25.73	-3.87	47.59
Ac-228	2.44	0.37	0.72	1.73	3.16
Bi-214	1.23	0.23	0.46	0.77	1.68
Pb-214	1.33	0.28	0.56	0.77	1.89
GBeta-K40	7.54	3.57	7.01	0.53	14.54
Iron Mountain Survey Unit					
			95% Confidence		
	Mean	Std Dev. (s)	(1.96*s)	Low Limit	High Limit
Gross Alpha	20.27	5.31	10.42	9.86	30.69
Gross Beta	17.74	9.95	19.49	-1.75	37.24
K-40	10.81	10.29	20.17	-9.36	30.99
Ac-228	1.98	0.36	0.70	1.28	2.67
Bi-214	1.08	0.33	0.65	0.43	1.73
Pb-214	1.22	0.33	0.64	0.58	1.86
GBeta-K40	6.93	2.48	4.86	2.07	11.79

Figure G-2. Iron Mountain Laboratory Results Graphic Comparison

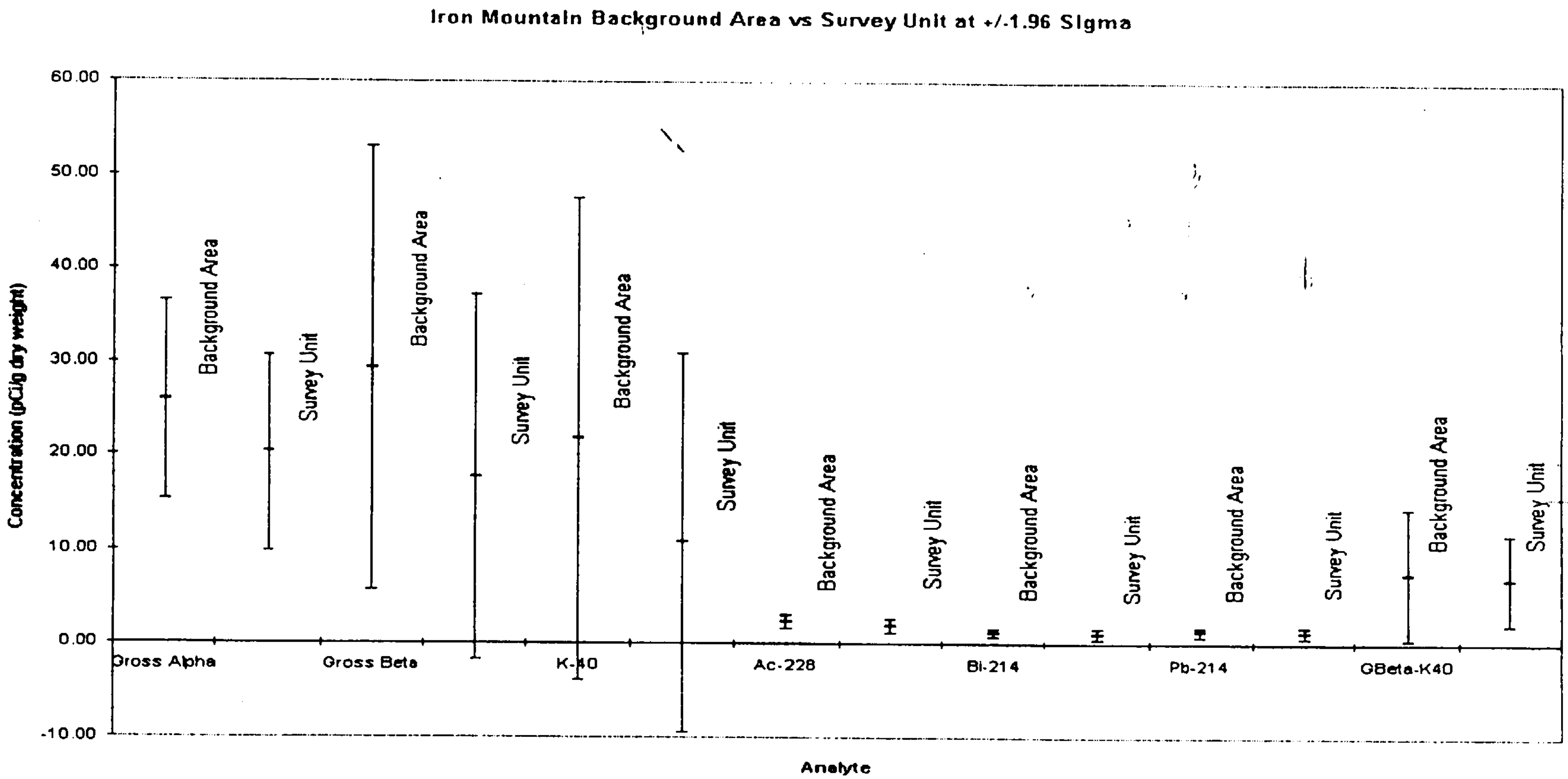


Table G-3. Iron Mountain Laboratory Results Descriptive Statistics

Iron Mountain Bkg Area	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	GBeta-K40
Mean	25.928571429	29.392857143	21.857142857	2.4428571429	1.225	1.3285714286	7.5357142857
Standard Error	1.0221470445	2.2778780189	2.4809935103	0.0690886578	0.0441333357	0.0536639413	0.6755012696
Median	24.5	29	20.5	2.35	1.2	1.3	6.5
Mode	22	19	5	2.2	1.2	1.3	6
Standard Deviation	5.408693766	12.05339751	13.128183665	0.3655828137	0.2335316617	0.283962886	3.5744167393
Sample Variance	29.253968254	145.28439153	172.34920635	0.1336507937	0.054537037	0.0806349206	12.776455026
Kurtosis	-0.794874987	-0.373410598	0.1612906307	2.2014456544	1.3294577861	-0.137395327	-0.633305769
Skewness	0.4036519312	0.5313402241	0.7809699462	1.1574169294	0.6893709514	0.6492859324	0.5365097051
Range	20	44	49	1.7	1.1	1.1	13
Minimum	16	12	5	1.9	0.8	0.9	2
Maximum	36	56	54	3.6	1.9	2	15
Sum	726	823	612	68.4	34.3	37.2	211
Count	28	28	28	28	28	28	28
Confidence Level(95.000%)	2.0033684276	4.4645522674	4.8626507257	0.1354110804	0.0864996205	0.1051792364	1.3239561995

Table G-3. Iron Mountain Laboratory Results Descriptive Statistics (Continued)

Iron Mountain Survey Unit	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	GBeta-K40
Mean	20.270833333	17.74375	10.814583333	1.975	1.0770833333	1.2166666667	6.9291666667
Standard Error	0.7670344381	1.4354611852	1.4856225549	0.0513557333	0.0478472362	0.0472030972	0.3577034502
Median	20.5	13	6	2	1.05	1.2	7
Mode	20	11	2	2	1.2	1.1	8
Standard Deviation	5.3141704716	9.9451668204	10.292694984	0.3558029577	0.3314953761	0.3270326507	2.4782421991
Sample Variance	28.240407801	98.906343085	105.93957004	0.1265957447	0.1098891844	0.1069503546	6.1416843972
Kurtosis	1.6228167781	-0.208760482	-0.207042293	1.5474056467	0.7991142881	0.3624715698	0.2450966228
Skewness	0.5061374417	0.9564125176	1.0499115421	0.2853878304	0.8902283121	0.5119018026	-0.464313412
Range	27.9	35.2	35.9	2	1.5	1.5	11
Minimum	9.1	6.8	0.1	1	0.5	0.6	0
Maximum	37	42	36	3	2	2.1	11
Sum	973	851.7	519.1	94.8	51.7	58.4	332.6
Count	48	48	48	48	48	48	48
Confidence Level(95.000%)	1.5033576474	2.8134480582	2.9117623907	0.1006552387	0.0937787208	0.0925162335	0.7010848414

Table G-4. Iron Mountain Pooled t-Tests (Gross Alpha)

t-Test: Two-Sample Assuming Equal Variances		
Iron Mountain Data	Background Area Gross Alpha	Survey Unit Gross Alpha
Mean	25.9285714286	20.2708333333
Variance	29.253968254	28.2404078014
Observations	28	48
Pooled Variance	28.610220399	
Hypothesized Mean Difference	0	
df	74	
t Stat	4.44810546634	
P(T<=t) one-tail	0.0000149960512133	
t Critical one-tail	1.66570771398	
P(T<=t) two-tail	0.0000299921024266	
t Critical two-tail	1.99254373001	

Table G-4. Iron Mountain Pooled t-Tests (Gross Alpha) (Continued)

t-Test: Two-Sample Assuming Equal Variances		
Iron Mountain Data	Background Area Gross Alpha	Survey Unit Gross Alpha
Mean	25.9285714286	20.2708333333
Variance	29.253968254	28.2404078014
Observations	28	48
Pooled Variance	28.610220399	
Hypothesized Mean Difference	3.4	
df	74	
t Stat	1.77503040861	
P(T<=t) one-tail	0.0400025402635	
t Critical one-tail	1.66570771398	
P(T<=t) two-tail	0.0800050805269	
t Critical two-tail	1.99254373001	

Table G-5. Iron Mountain Pooled t-Test (Gross Beta)

t-Test: Two-Sample Assuming Equal Variances		
Iron Mountain Data	Background Area Gross Beta	Survey Unit Gross Beta
Mean	29.3928571429	17.74375
Variance	145.284391534	98.9063430851
Observations	28	48
Pooled Variance	115.828063465	
Hypothesized Mean Difference	0	
df	74	
t Stat	4.55175187966	
P(T<=t) one-tail	0.0000102301203968	
t Critical one-tail	1.66570771398	
P(T<=t) two-tail	0.0000204602407937	
t Critical two-tail	1.99254373001	

Table G-6. Iron Mountain Pooled t-Test (K-40)

t-Test: Two-Sample Assuming Equal Variances		
Iron Mountain Data	Background Area K-40	Survey Unit K-40
Mean	21.8571428571	10.8145833333
Variance	172.349206349	105.939570035
Observations	28	48
Pooled Variance	130.170113015	
Hypothesized Mean Difference	0	
df	74	
t Stat	4.07011749243	
P(T<=t) one-tail	0.0000582059255805	
t Critical one-tail	1.66570771398	
P(T<=t) two-tail	0.000116411851161	
t Critical two-tail	1.99254373001	

Table G-7. Iron Mountain Pooled t-Test (Gross Beta Minus K-40)

t-Test: Two-Sample Assuming Equal Variances		
Iron Mountain Data	Background Area GBeta-K40	Survey Unit GBeta-K40
Mean	7.53571428571	6.92916666667
Variance	12.7764550265	6.14168439716
Observations	28	48
Pooled Variance	8.56247908623	
Hypothesized Mean Difference	0	
df	74	
t Stat	0.871681800522	
P(T<=t) one-tail	0.193100678419	
t Critical one-tail	1.66570771398	
P(T<=t) two-tail	0.386201356839	
t Critical two-tail	1.99254373001	

Table G-8. Rattlesnake Gulch Laboratory Results Statistical Data Summary

Rattlesnake Gulch Background Area					
			95% Confidence		
	Mean	Std Dev. (s)	(1.96*s)	Low Limit	High Limit
Gross Alpha	19.46	9.95	19.50	-0.04	38.97
Gross Beta	10.82	5.09	9.99	0.83	20.80
K-40	2.98	1.68	3.30	-0.32	6.28
Ac-228	1.89	0.79	1.54	0.35	3.43
Bi-214	1.02	0.48	0.93	0.09	1.95
Pb-214	1.17	0.52	1.01	0.16	2.18
GBeta-K40	7.84	4.39	8.61	-0.77	16.44
Rattlesnake Gulch Survey Unit					
			95% Confidence		
	Mean	Std Dev. (s)	(1.96*s)	Low Limit	High Limit
Gross Alpha	19.63	8.17	16.01	3.61	35.64
Gross Beta	11.34	4.42	8.66	2.68	20.01
K-40	4.76	2.60	5.10	-0.35	9.86
Ac-228	1.67	0.68	1.34	0.33	3.01
Bi-214	0.97	0.44	0.86	0.11	1.83
Pb-214	1.06	0.43	0.85	0.21	1.91
GBeta-K40	6.59	3.15	6.17	0.42	12.76

Figure G-3. Rattlesnake Gulch Graphic Comparison

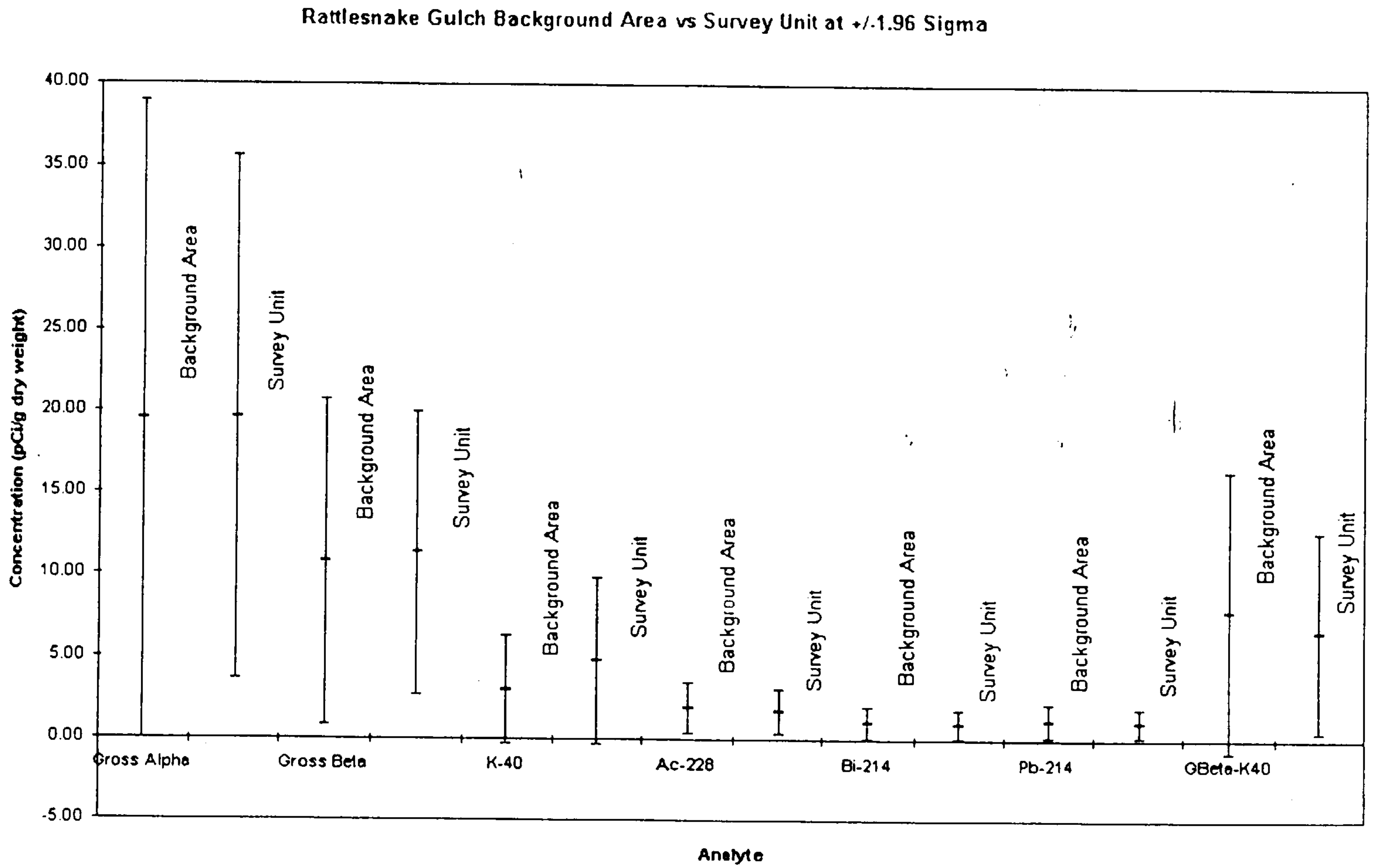


Table G-9. Rattlesnake Gulch Laboratory Results Descriptive Statistics

Rattlesnake Gulch Bkg Area	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	GBeta-K40
Mean	19.464705882	10.817647059	2.9823529412	1.8882352941	1.0235294118	1.1705882353	7.8352941176
Standard Error	2.4139444956	1.2355706973	0.4083895284	0.1907574594	0.1152138076	0.1250778304	1.0648094685
Median	18	10	3	1.6	1	0.9	7.9
Mode	34	20	3	1.2	0.5	0.7	9
Standard Deviation	9.9529481296	5.094388493	1.6838331621	0.7865131538	0.4750386981	0.5157091063	4.3903219097
Sample Variance	99.061176471	25.952794118	2.8352941176	0.6186029412	0.2256617647	0.2659558824	19.274926471
Kurtosis	-1.459947411	-0.832920692	-1.087634947	-1.642328261	-1.549731405	-1.055812844	-0.661442265
Skewness	0.3303963903	0.544755832	0.1441953011	0.1422894402	0.2543395198	0.476626036	0.4435241878
Range	27.1	15.9	5.4	2.2	1.2	1.7	14.7
Minimum	7.9	4.1	0.6	0.8	0.5	0.5	2.3
Maximum	35	20	6	3	1.7	2.2	17
Sum	330.9	183.9	50.7	32.1	17.4	19.9	133.2
Count	17	17	17	17	17	17	17
Confidence Level(95.000%)	4.7312372662	2.4216704812	0.8004275821	0.3738771965	0.225814579	0.2451476799	2.0869851183

Table G-9. Rattlesnake Gulch Laboratory Results Descriptive Statistics (Continued)

Rattlesnake Gulch Survey Unit	Gross Alpha	Gross Beta	K-40	Ac-228	Bi-214	Pb-214	GBeta-K40
Mean	19.626666667	11.344444444	4.7555555556	1.6688888889	0.9688888889	1.0577777778	6.5888888889
Standard Error	1.2182841055	0.6588063552	0.3881522605	0.1017434991	0.0653523644	0.0647831573	0.4692054559
Median	19	11	4	1.6	0.9	1	6
Mode	13	11	3	1.3	0.8	0.7	8
Standard Deviation	8.1724982271	4.4194073829	2.6038045203	0.6825161411	0.4383969881	0.4345786302	3.1475258842
Sample Variance	66.789727273	19.531161616	6.7797979798	0.4658282828	0.1921919192	0.1888585859	9.9069191919
Kurtosis	0.892118922	0.3570636636	1.7440057102	-0.188432444	0.4578696488	0.7109021377	0.0303420656
Skewness	0.6349179205	0.8227618152	1.2266126879	0.2736772085	0.8255789642	0.9160204008	0.4904459905
Range	40.2	18.2	12	2.8	1.8	1.9	13.6
Minimum	4.8	4.8	1	0.3	0.3	0.3	0.4
Maximum	45	23	13	3.1	2.1	2.2	14
Sum	883.2	510.5	214	75.1	43.6	47.6	296.5
Count	45	45	45	45	45	45	45
Confidence Level(95.000%)	2.3877894339	1.291234817	0.7607633246	0.1994132987	0.1280880909	0.126972467	0.9196244331

Table G-10. Rattlesnake Gulch Pooled t-Test (Gross Alpha)

t-Test: Two-Sample Assuming Equal Variances		
Rattlesnake Gulch Data	Background Area Gross Alpha	Survey Unit Gross Alpha
Mean	19.4647058824	19.6266666667
Variance	99.0611764706	66.7897272727
Observations	17	45
Pooled Variance	75.3954470588	
Hypothesized Mean Difference	0	
df	60	
t Stat	-0.0655197427663	
P(T<=t) one-tail	0.473989004921	
t Critical one-tail	1.67064854395	
P(T<=t) two-tail	0.947978009842	
t Critical two-tail	2.00029717234	

Table G-11. Rattlesnake Gulch Pooled t-Test (Gross Beta)

t-Test: Two-Sample Assuming Equal Variances		
Rattlesnake Gulch Data	Background Area Gross Beta	Survey Unit Gross Beta
Mean	10.8176470588	11.3444444444
Variance	25.9527941176	19.5311616162
Observations	17	45
Pooled Variance	21.2435969499	
Hypothesized Mean Difference	0	
df	60	
t Stat	-0.401480500874	
P(T<=t) one-tail	0.344746399912	
t Critical one-tail	1.67064854395	
P(T<=t) two-tail	0.689492799823	
t Critical two-tail	2.00029717234	