Attachment M-1

Radiological Survey
Los Alamos National Laboratory
Former Technical Area 10, Bayo Canyon Aggregate Area
prepared by ERG
(on CD included with this document)

Radiological Survey

Los Alamos National Laboratory

Former Technical Area 10 - Bayo Canyon Aggregate Area

Prepared for:

TerranearPMC

1911 Central Ave.
2nd Floor
Los Alamos, NM 87544

Prepared by:

ERG

Environmental Restoration Group, Inc.
8809 Washington St. NE • Suite 150
Albuquerque, NM 87113

January, 2008

1.0 Introduction

TerranearPMC (TPMC) retained Environmental Restoration Group, Inc. (ERG) to conduct a walk-over radiological survey of portions of the former Technical Area 10 in Bayo Canyon, referred to as Bayo Canyon Aggregate Area. The survey data were collected to assist Los Alamos National Laboratory (LANL) in its efforts to meet the New Mexico Environmental Department (NMED) Consent Order requirement of determining whether further cleanup of the site is required. The survey was performed over eight days from July 22 to October 10, 2007.

The survey was performed using a Global Positioning System (GPS) coupled to radiological instrumentation. A diamond shaped Pancake Geiger-Mueller (G-M) detector array was used for the survey. The G-M detector is capable of detecting alpha, beta, and gamma radiation. Since the radionuclides of concern at the site consist of Strontium-90, a high energy beta emitter, and depleted uranium, an alpha, beta, and gamma emitter, the G-M detector was selected for this project.

2.0 GPS-Radiological Surveys

2.1 GPS Survey Method

The detector chosen for the survey was the Ludlum Model 44-94, a four G-M tube array arranged in a diamond shape. G-M tube detectors have a thin mica window and a high efficiency for alpha and beta particles with a much lower efficiency for gamma rays.

The walk-over survey was designed to detect only the beta and gamma component of the radiation since the alpha particles will not be detected unless the detector is within an inch or two of the surface. Each GPS-radiological survey system consisted of a Ludlum Model 2221 ratemeter/scaler with a Ludlum Model 44-94 G-M detector coupled to a Trimble ProXRS mapping grade GPS. The Ludlum Model 2221s were operated in fast response ratemeter mode allowing for count rates tagged with corresponding coordinates to be collected at 1-second intervals. For the walk-over surveys the systems were carried in backpacks with the detectors held approximately 6 inches above the ground surface. Each detector line-spacing was approximately 5 feet and the walking survey speed was approximately 2.5-feet per second. At the end of each work day, the field data were downloaded into a laptop computer and processed on site using a combination of Trimble Pathfinder Office and ESRI ArcView GIS computer applications.

2.2 GPS Survey Results

The data from the survey are presented in Figures 1 through 3, where the colors correspond to the detector count-rate range in which each datum fell. More than 120,000 data points were recorded throughout 23 acres of Bayo Canyon from four separate areas including Consolidated Unit 10-001(a)-99, Consolidated Unit 10-002(a)-99, Solid Waste Management Unit (SWMU) 10-009, and SWMU 10-004 (a). The calculated mean value for detector count rates was 451 cpm with a standard deviation 66 cpm, as shown in Table 1. Color ranges for data presentation in each figure were chosen based upon the survey mean plus two or three standard deviations. Thus in each figure, data values less than mean plus two standard deviations is colored gray, data values from the mean plus two standard deviations to mean plus three standard deviations is colored green, and data values more than the mean plus three standard deviations is colored red. The statistics of the data set are shown in Table 1.

Table 1. Survey Count Rate Data

Detector	Readings	Mean (cpm)	Standard Deviation	Maximum Reading (cpm)	Minimum Reading (cpm)
Ludlum Model 44-94	121,702	451	66	3,126	175

Figure 1 shows the survey results for Consolidated Unit10-001(a)-99. There were six locations with elevated readings identified for further investigation. Locations 1 through 5 were investigated October 10, 2007 and small (millimeter size) yellow fragments were observed disseminated in the surface soil, suspected to be oxidized depleted uranium. Location 6 had previously been identified and investigated on August 24, 2007. There was no visible material as observed at Locations 1 through 5, and the elevated readings could not be reproduced.

Figure 1 also shows the survey results for SWMU 10-004(a). No elevated readings were detected for this area.

Figure 2 shows the survey results for SWMU 10-009. An area of elevated readings, noted on the figure as Location 7, was identified and further investigated. Again, small yellow fragments (millimeter size) suspected to be oxidized depleted uranium were found disseminated in the surface soil.

Figure 3 shows the survey results for Consolidated Unit 10-002(a)-99 which included the area where the field team trailers were located. At locations 8 and 9 elevated readings were determined to be strontium-90 in soil. Locations 10 and 11 are areas within and near a fenced area (SWMU 10-007 "The Central Area") where elevated readings were detected.

Many of the elevated readings appear as lines or stringers of elevated values. This is due to the response characteristics of the Ludlum Model 2221. The Ludlum 2221 manual states "Fast response = 4 +/- 1 second, Slow response = 22 seconds +/- 2 seconds, all response times are measured from 10-90% of final reading". From discussions with Ludlum representatives it was determined that the response time is also a factor of count rate level. At a very low count rates, as observed in Bayo Canyon, the response time is much slower than at a high count rates. The net effect is the occurrence of a linear array of elevated count rates along the walked path (Figure 3).

2.3 GPS Survey Data Quality Control

All radiological instrumentation was calibrated within a six-month period prior to use using NIST traceable sources and pulser. The instrumentation was also function checked before and after use each day. Function check forms and calibration sheets are included in Appendix A.

3.0 Comparison Between Radiological and Geophysics Data

A grid system, consisting of 257 10-meter by 10-meter grids, was created that overlay an area where both EM geophysics and radiological data had been collected at Consolidated Unit 10-001(a)-99, the former firing sites and where the majority of shrapnel is concentrated. Comparison of the EM geophysics and radiological survey data was made by calculating the averages of all readings that fell within each 10-meter by 10-meter grid block. A comparison of the radiological survey data versus the geophysics survey data is shown in Figure 4. With the exception of one grid block there is no correlation between the two datasets. In other words, there is no indication the presence of metallic objects proves the presence of radioactive materials or vice versa. The one grid block with a very high radiological count rate, 3126 cpm, and a high EM geophysics survey value, 1125 ERM is considered a coincidence.

Figure 1 – Survey Data of Consolidated Unit 10-001(a)-99 and SWMU 10-004(a) in Bayo Canyon

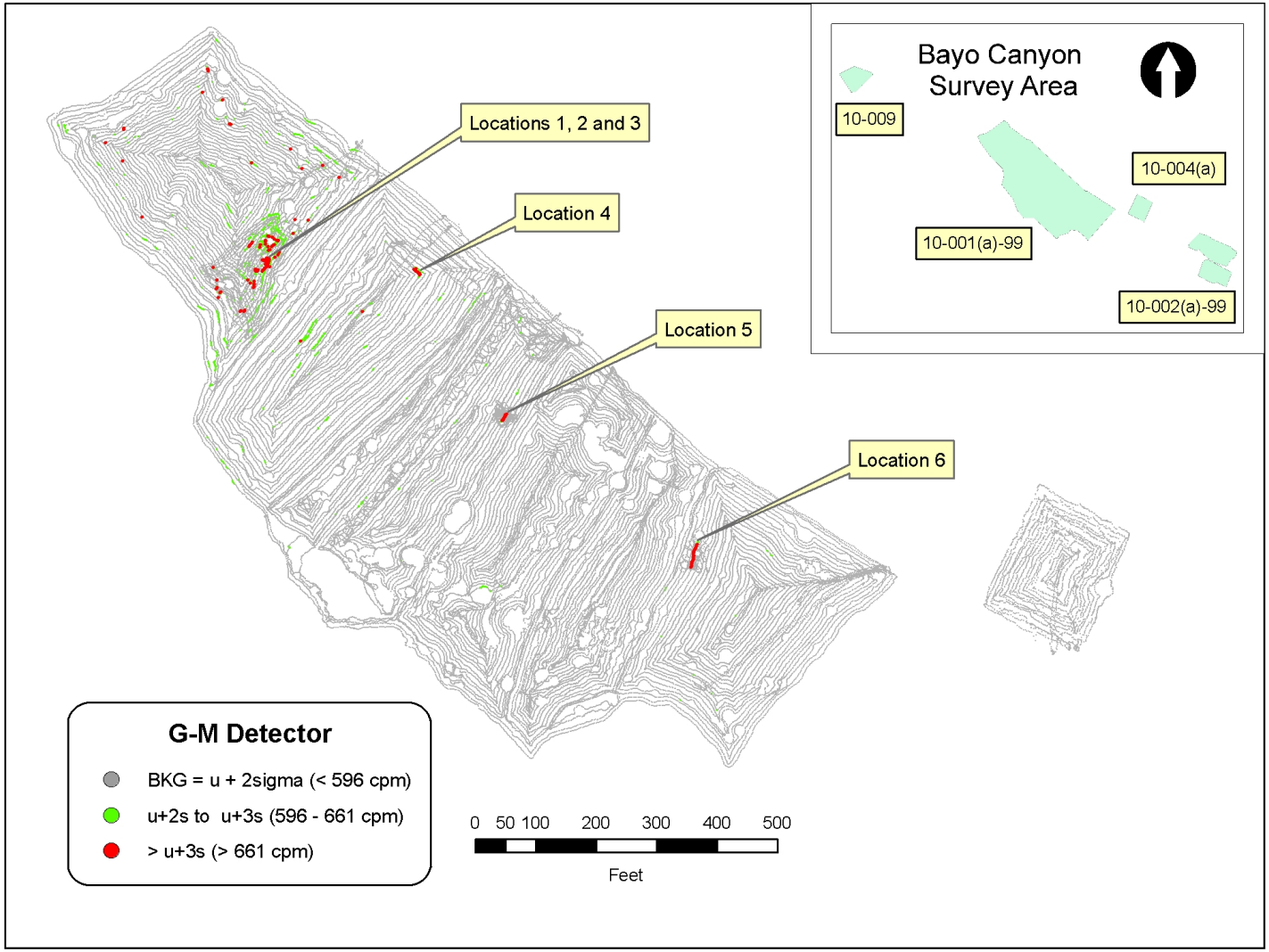


Figure 2 – Survey of SWMU 10-009 in Bayo Canyon

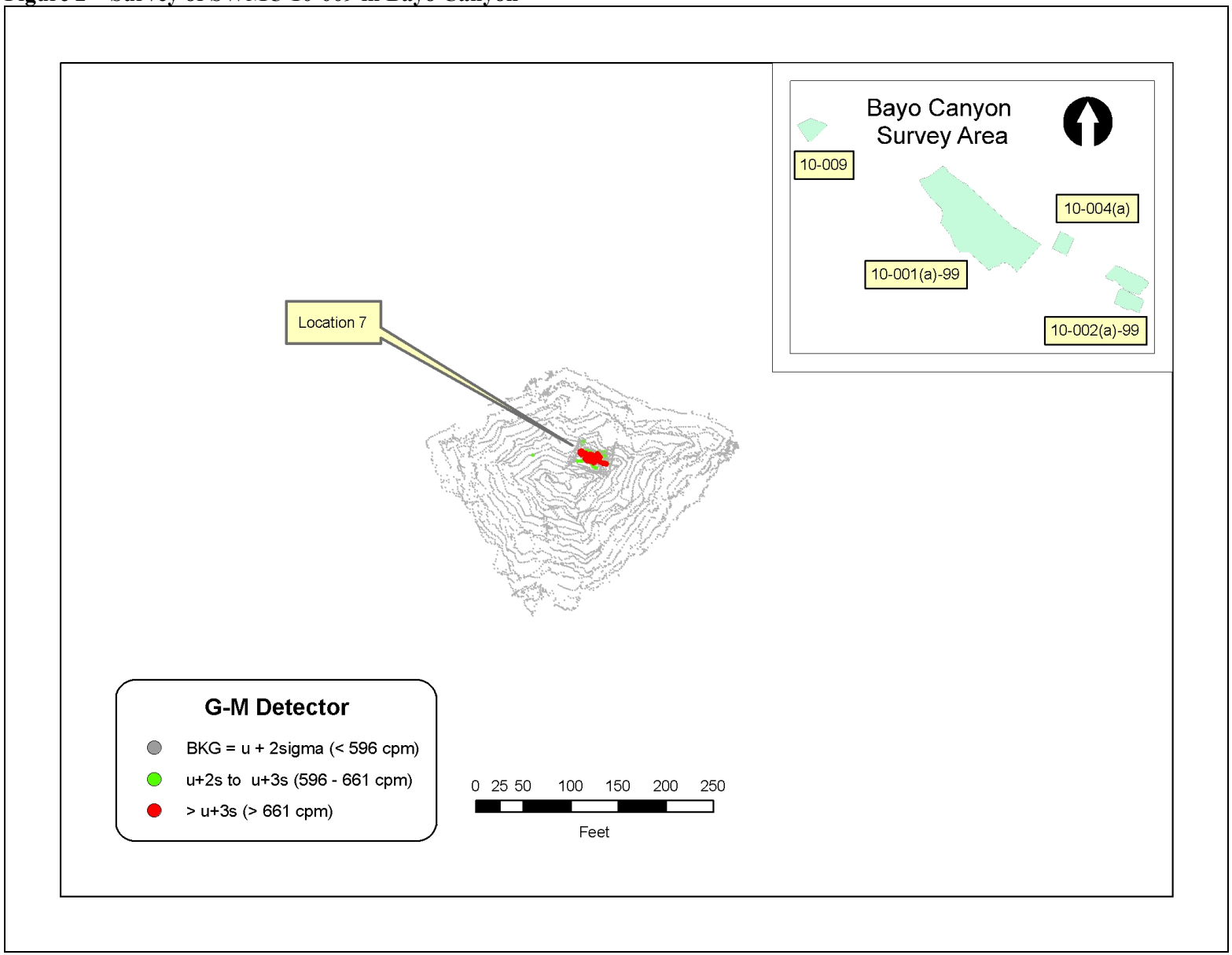


Figure 3 – Survey Data of Consolidated Unit 10-002(a)-99 in Bayo Canyon

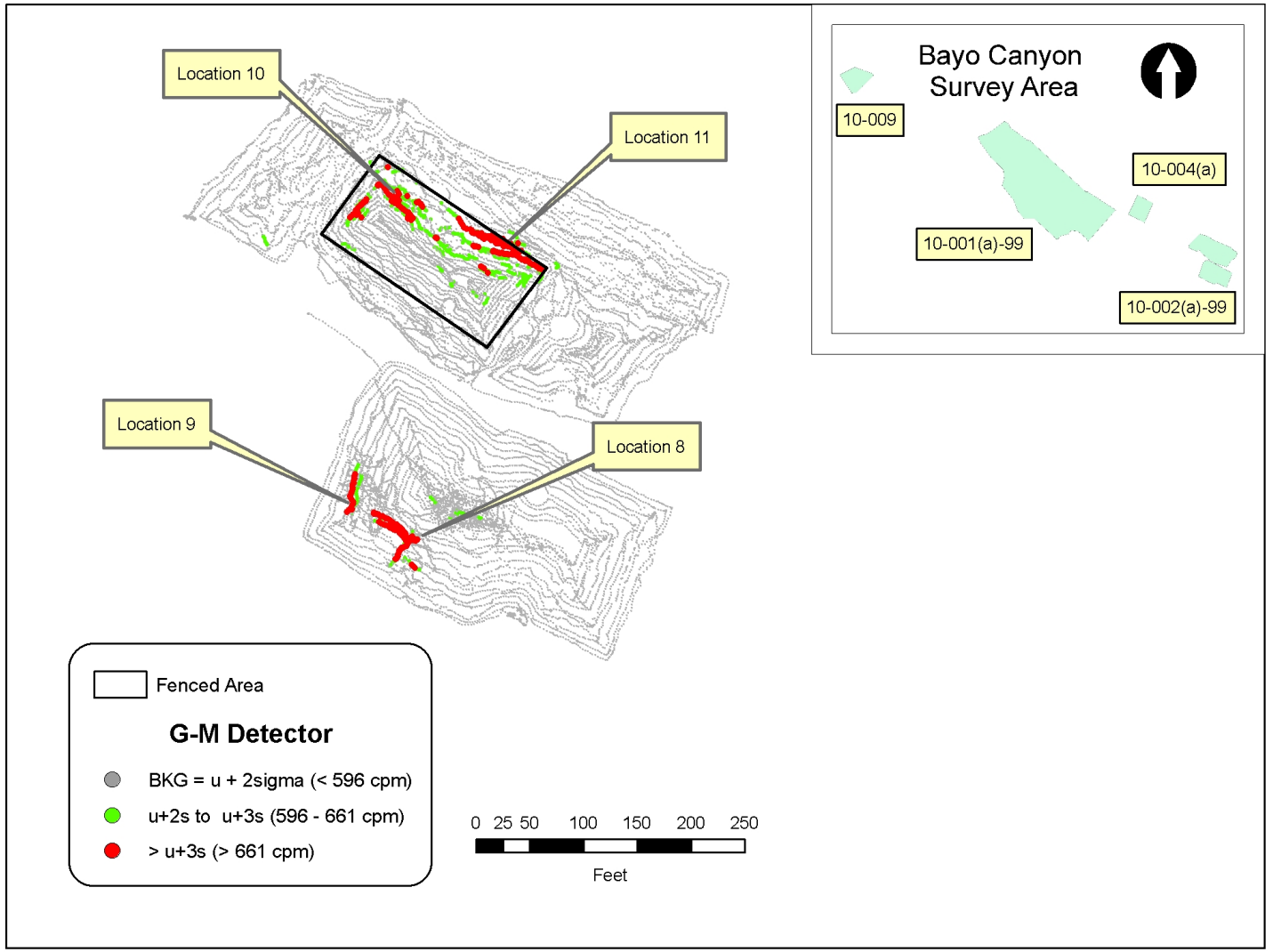
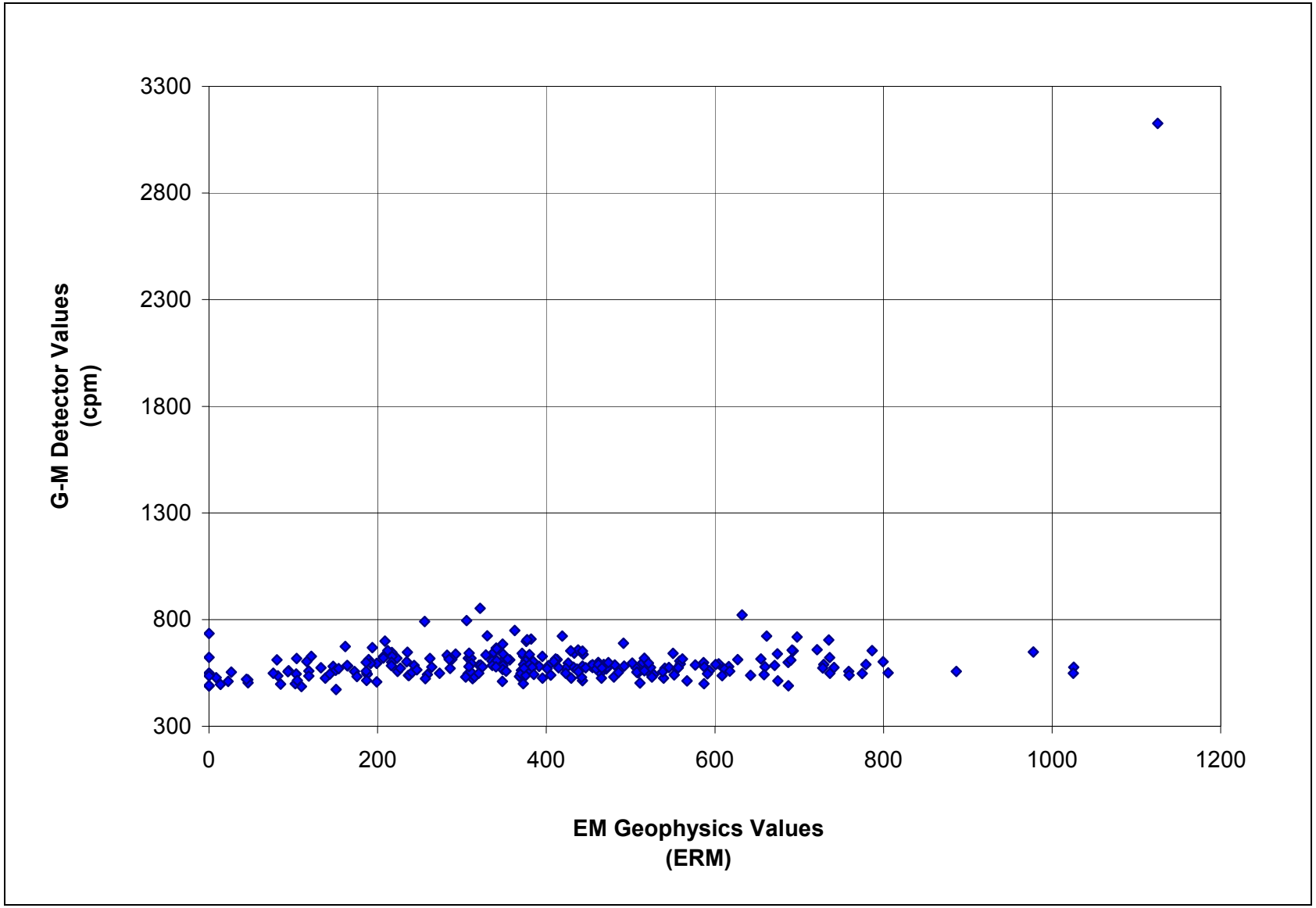


Figure 4. Comparison of Radiological Survey Data and Geophysics Survey Data



4.0 Conclusion

The radiological survey data indicate that depleted uranium and strontioum-90 are present within the soil surface in Bayo Canyon at select and isolated areas. Because of the transect spacing and the speed of the walk-over survey, it is possible there are other areas where sources are present on the surface and were not observed in this survey. The survey does not have the capability of detecting smaller source values buried beneath the surface (approximately more than three inches). There is no correlation of the radiological data (cpm) with the EM geophysical data (ERM).

Appendix A

A

ERG

Daily Function Check Form

DMC Field
Site: Trailer

Ratemeter: 2221
Detector: 4454
Source: Sr Y-90
Distance to Source: ≈1"

Serial No. 228808
Serial No. PR255841
Activity: 4370 dpm @ 3-26-05

Cal. Due Date 7-13-08
Cal. Due Date 7-13-08
Serial No. 5442-05

Notes:

	Date	Time	Battery	High Voltage	Threshold (mv)	Gross Counts (CPM)	Background (CPM)	Net Counts (CPM)	Efficiency (CPM/DPM)	Initials	Location
*	7-16-07	0720	5.3	900	400	646	218	428	0.10	ESH	
	7-23-07	0917	6.3	900	400	668	251	417	0.10	ESH	Trailer
	7-23-07	1523	6.0	894	397	674	242	432	0.10	ESA	"
**	7-24-07	0731	6.1	902	400	644	265	379	0.09	ESH	"
	7-25-07	0730	6.0	902	400	638	251	387	0.09	ESH	"
**	7-25-07	1337	5.5	895	399	661	265	396	0.09	ESA	"
	7-25-07	1551	5.3	893	398	640	285	355	0.08	ESA	"
	7-26-07	0739	5.7	901	400	641	263	378	0.09	ESH	"
	7-26-07	1422	5.6	895	398	664	246	418	0.10	ESH	"
						652	254				

n=9

Reviewed By: Clark

Date: 8/3/07

* Did not use

** Broken GM TUBE

ERG

A

Daily Function Check Form

Site: Fmc Field Trailer

Ratemeter: 2221 Serial No. 228808 Cal. Due Date 7-13-08

Detector: 44-94 Serial No. PR255841 Cal. Due Date 7-13-08

Source: Sr/Y-90 Activity: 4520dpm@3-28-05 Serial No. S-442-05

Distance to Source: ≈1'

Notes: _____

Date	Time	Battery	High Voltage	Threshold (mv)	Gross Counts (CPM)	Background (CPM)	Net Counts (CPM)	Efficiency (CPM/DPM)	Initials	Location
7-30-07	0747	5.8	902	400	646	246	400	6.09	ASH	Trailer
7-30-07	1021	5.6	896	398	654	243	411		ASH	"
								9.4%		
8-27-07	0750	6.3	899	399	684	238	446	10.2%	CSH	"
8-27-07	1305	6.0	893	397	598	293/280	(312)	0.071	CSH	"
8-28-07	0655	6.1	900	400	~~597~~ 613	~~259~~ 246	367	0.084	CSH	"
8-28-07	1002	6.0	897	399	675	266	409	9.4%	CSH	"
								~~0.091~~		
10-10-07	0823	5.8	900	400	595	240	355	0.08	CSH	"
10-10-07	1132	5.7	897	399	611	287	324	0.074	CSH	"

Reviewed By: _____ Date: 1/24/08

B

ERG

Daily Function Check Form

Site: DMC Tent Trailers

Ratemeter: 2221
Detector: 44-94
Source: Sr/Y-90
Distance to Source: ≈ 1"

Serial No. 218587
Serial No. PR255840
Activity: 4370 dpm @ 3.28.05

Cal. Due Date 7.13.08
Cal. Due Date 7-13-08
Serial No. 5442.05

Notes:

	Date	Time	Battery	High Voltage	Threshold (mv)	Gross Counts (CPM)	Background (CPM)	Net Counts (CPM)	Efficiency (CPM/DPM)	Initials	Location ~~Trailer~~ ASK
*	7.16.07	0730	6.2	895	400	619	246	373	0.09	ESH	
	7.23.07	0908	6.2	900	400	648	225	423	0.10	ESH	Trailer
	7.23.07	1518	6.1	895	398	609	240	369	0.08	ESH	"
**	7.24.07	0731	6.1	902	401	642	248	394	~~0.09~~ 0.09 ESH	ESH	"
	7.24.07	1251	6.0	900	401	637	254	383	0.09	ESH	"
	7.24.07	1527	5.9	897	399	641	313	328	0.08	ESH	"
	7.25.07	0730	6.0	902	401	636	264	372	0.09	ESH	"
	7.25.07	1551	5.8	896	399	638	273	365	0.08	ESH	"
	7.26.07	0737	5.9	901	401	642	238	404	0.09	ESH	"
	7.26.07	1422	5.8	897	399	627	245	378	0.09	ESH	"
					μ	634	255		/		

Reviewed By: Charlie

$\lambda = 10$

Date: 8/3/07

* Did not use
** Broken GM tube

B

ERG

Daily Function Check Form

Site: PMC Fold Trailer

Ratemeter: 2221 Serial No. 218587 Cal. Due Date 7-13-08

Detector: 44-4 Serial No. PR 255840 Cal. Due Date 7-13-05

Source: Sr/-90 Activity: 4370 µCi @ 3-28-05 Serial No. 5442-05

Distance to Source: ≈1"

Notes:

Date	Time	Battery	High Voltage	Threshold (mv)	Gross Counts (CPM)	Background (CPM)	Net Counts (CPM)	Efficiency (CPM/DPM)	Initials	Location
7-30-07	0747	5.9	900	401	610	251	359	0.082	ESH	"
7-30-07	1016	5.8	897	400	613	279	334	0.078/0.077	ESH	"
8-27-07	0730	5.8	900	401	671	247	424	0.097	ESH	"
8-27-07	1305	5.6	895	398	625	249	376	0.086	ESH	"
8-28-07	0655	5.7	900	400	ESH 597 597	ESH 231 231	366	0.085/0.084	ESH	"
D.D	not use									

Reviewed By: CP Date: 1/14/08

A

Certificate of Calibration

Ratemeter / Scaler Certificate of Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE. Suite 150
Albuquerque, NM 87113
(505) 298-4224

Manufacturer: Ludlum Model: 2221r Serial No.: 228808

All Ranges Calibrat d Electronically; Ludlum Pulser Generator Serial No.: ☐ 97743 ☑ 201932

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

☑ Mechanical ck. ☑ Meter Zeroed ☑ Gootropism ck. ☑ F/S Response ck. ☑ Audio ck.

☑ THR/WIN ck. High Voltage ck.: ☑ 500v ☑ 1000v ☑ 1500v ☑ Battery ck. (min 4.4 vdc)

Threshold Setting: 40 mV

Instrument found within tolerance (+/- 10%) ☑ Yes ☐ No

Refer nce Calibration Point	Instrument "As Found Reading"	Instrument Meter Reading
400 Kcpm	+/- 10%	400 Kcpm
100 Kcpm	+/- 10%	100 Kcpm
40 Kcpm	+/- 10%	40 Kcpm
10 Kcpm	+/- 10%	10 Kcpm
4 Kcpm	+/- 10%	4 Kcpm
1 Kcpm	+/- 10%	1 Kcpm
400 cpm	+/- 10%	400 cpm
100 cpm	+/- 10%	100 cpm

Reference Calibration Point	Instrument "As Found Reading"	Log Scale Count Rate	Integrated Counts (1-minute count)
400 Kcpm	+/- 10%	400 Kcpm	399088
40 Kcpm	+/- 10%	40 Kcpm	39910
4 Kcpm	+/- 10%	4 Kcpm	3991
400 cpm	+/- 10%	400 cpm	399

Calibrated By: [signature] Calibration Date: 7-13-07

Calibration Due: ~~7-13-08~~ RSH 7-13-08

Reviewed By: [signature] Date: 7/13/07

Certificate of Calibration

Ratemeter / Scaler Certificate of Calibration

ERG
Environmental Restoration Group, Inc
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Manufacturer: Ludlum Model: 2221r Serial No.: 228808

All Ranges Calibrated Electronically; Ludlum Pulser Generator Serial No.: ☐ 97743 ☑ 201932

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

☑ Mechanical ck. ☑ Meter Zeroed ☑ Geotropism ck. ☑ F/S Response ck. ☑ Audio ck.

☑ THR/WIN ck. High Voltage ck.: ☑ 500v ☑ 1000v ☑ 1500v ☐ Battery ck. (min 4.4 vdc)

Threshold Setting: 40 mV

Instrument found within tolerance (+/- 10%) ☑ Yes ☐ No

Reference Calibration Point	Instrument "As Found Reading"	Instrument Meter Reading
400 Kcpm	+/- 10%	400 Kcpm
100 Kcpm	+/- 10%	100 Kcpm
40 Kcpm	+/- 10%	40 Kcpm
10 Kcpm	+/- 10%	10 Kcpm
4 Kcpm	+/- 10%	4 Kcpm
1 Kcpm	+/- 10%	1 Kcpm
400 cpm	+/- 10%	400 cpm
100 cpm	+/- 10%	100 cpm

Reference Calibration Point	Instrument "As Found Reading"	Log Scale Count Rate	Integrated Counts (1-minute count)
400 Kcpm	+/- 10%	400 Kcpm	399115
40 Kcpm	+/- 10%	40 Kcpm	39916
4 Kcpm	+/- 10%	4 Kcpm	3991
400 cpm	+/- 10%	400 cpm	399

Calibrated By: [signature] Calibration Date: 10-5-07

Calibration Due: 10-5-08

Reviewed By: [signature] Date: 10/5/07

A

Efficiency Calibration

ERG
Environmental Restoration Group, Inc
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255841 #1

Counter Mfg.: Ludlum Model: 2221 Serial No: 228808

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Cuely

Detector geometry to source: ☑ Face, ☐ Planchett/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchett/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts:	2590 cpm	Gross Sr/Y-90 counts:	1068 cpm
Background counts:	206/51.5 cpm	Background counts:	206/51.5 cpm
Net Tc-99 counts:	2538.5 cpm	Net Sr/Y-90 counts:	1016.5 cpm

Comments:

4π Efficiency for Tc-99 Source: 14 % 4π Efficiency for Sr/Y-90 Source: 27 %

Efficiency = Net source counts (cpm) / Source activity (cpm.dpm)

Calibrated By: [signature] Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: [signature] Date: 7/13/07

A

Efficiency Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255841 #2

Counter Mfg.: Ludlum Model: 2221 Serial No: 228808

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Cable

Detector geometry to source: ☑ Face, ☐ Planchett/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchett/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts: 2247 cpm Gross Sr/Y-90 counts: 1108 cpm

Background counts: 206/51.5 cpm Background counts: 206/51.5 cpm

Net Tc-99 counts: 2195.5 cpm Net Sr/Y-90 counts: 1056.5 cpm

Comments:

4π Efficiency for Tc-99 Source: 12 % 4π Efficiency for Sr/Y-90 Source: 28 %

Efficiency = Net source counts (cpm) / Source activity (cpm,dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

A

Efficiency Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255841 #3

Counter Mfg.: Ludlum Model: 2221 Serial No: 228808

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Curly

Detector geometry to source: ☑ Face, ☐ Planchett/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchett/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts: 2581 cpm Gross Sr/Y-90 counts: 1109 cpm

Background counts: 206/51.5 cpm Background counts: 206/51.5 cpm

Net Tc-99 counts: 2129.5 cpm Net Sr/Y-90 counts: 1057.5 cpm

Comments:

4π Efficiency for Tc-99 Source: 14 % 4π Efficiency for Sr/Y-90 Source: 28 %

Efficiency = Net source counts (cpm) / Source activity (cpm.dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

A

Efficiency Calibration

ERG
Environmental Restoration Group, Inc
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.:	Ludlum	Model:	44-94	Serial No:	PR255841 #4
Counter Mfg.:	Ludlum	Model:	2221	Serial No:	228808

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Curly

Detector geometry to source: ☑ Face, ☐ Planchett/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchett/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts:	2685 cpm	Gross Sr/Y-90 counts:	1129 cpm
Background counts:	206 / 51.5 cpm	Background counts:	206 / 51.5 cpm
Net Tc-99 counts:	2633.5 cpm	Net Sr/Y-90 counts:	1077.5 cpm

Comments:

4π Efficiency for Tc-99 Source: 15 % 4π Efficiency for Sr/Y-90 Source: 29 %

Efficiency = Net source counts (cpm) / Source activity (cpm.dpm)

Calibrated By: _____ Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: _____ Date: 7/14/07

B

Certificate of Calibration

Ratemeter / Scaler Certificate of Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE. Suite 150
Albuquerque, NM 87113
(505) 298-4224

Manufacturer: Ludlum Model: 2221r Serial No.: 218587

All Ranges Calibrated Electronically; Ludlum Pulser Generator Serial No.: ☐ 97743 ☑ 201932

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registrarion No. 481-3 • Calibration of Radiation Detection Instruments & Devices

☑ Mechanical ck. ☑ Meter Zeroed ☑ Geotropism ck. ☑ F/S Response ck. ☑ Audio ck.

☑ THR/WIN ck. High Voltage ck.: ☑ 500v ☑ 1000v ☑ 1500v ☑ Battery ck. (min 4.4 vdc)

Threshold Setting: 40 mV

Instrument found within tolerance (+/- 10%) ☑ Yes ☐ No

Reference Calibration Point	Instrument "As Found Reading"	Instrument Meter Reading
400 Kcpm	+/- 10%	400 Kcpm
100 Kcpm	+/- 10%	100 Kcpm
40 Kcpm	+/- 10%	40 Kcpm
10 Kcpm	+/- 10%	10 Kcpm
4 Kcpm	+/- 10%	4 Kcpm
1 Kcpm	+/- 10%	1 Kcpm
400 cpm	+/- 10%	400 cpm
100 cpm	+/- 10%	100 cpm

Reference Calibration Point	Instrument "As Found Reading"	Log Scale Count Rate	Integrated Counts (1-minute count)
400 Kcpm	+/- 10%	400 Kcpm	399705
40 Kcpm	+/- 10%	40 Kcpm	39972
4 Kcpm	+/- 10%	4 Kcpm	3997
400 cpm	+/- 10%	400 cpm	400

Calibrated By: [signature] Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: [signature] Date: 7/13/07

Efficiency Calibration

B

ERG
Environmental Restoration Group, Inc
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255840 #1

Counter Mfg.: Ludlum Model: 2221 Serial No: 218587

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Curly

Detector geometry to source: ☑ Face, ☐ Planchet/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchet/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts:	2997 cpm	Gross Sr/Y-90 counts:	1128 cpm
Background counts:	205 / 51.3 cpm	Background counts:	205 / 51.3 cpm
Net Tc-99 counts:	2945.7 cpm	Net Sr/Y-90 counts:	1076.7 cpm

Comments:

4π Efficiency for Tc-99 Source: 17 % 4π Efficiency for Sr/Y-90 Source: 29 %

Efficiency = Net source counts (cpm) / Source activity (cpm,dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

Efficiency Calibration

5

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255840 #2

Counter Mfg.: Ludlum Model: 2221 Serial No: 218587

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 - Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch, ☐ 5 foot, ☑ Other: Cuely

Detector geometry to source: ☑ Face, ☐ Planchett/In tray, ☐ Side, ☐ Other:

Distance to source: ☑ Contact, ☐ Planchett/In tray, ☐ 6 Inches, ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts: 2847 cpm Gross Sr/Y-90 counts: 1168 cpm

Background counts: 205 / 51.3 cpm Background counts: 205 / 51.3 cpm

Net Tc-99 counts: 2795.7 cpm Net Sr/Y-90 counts: 1116.7 cpm

Comments:

4π Efficiency for Tc-99 Source: 16 % 4π Efficiency for Sr/Y-90 Source: 30 %

Efficiency = Net source counts (cpm) / Source activity (cpm.dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

B

Efficiency Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255840 #3

Counter Mfg.: Ludlum Model: 2221 Serial No: 218587

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch. ☐ 5 foot. ☑ Other: Cuely

Detector geometry to source: ☑ Face. ☐ Planchett/In tray. ☐ Side. ☐ Other:

Distance to source: ☑ Contact. ☐ Planchett/In tray. ☐ 6 Inches. ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts: 3014 cpm Gross Sr/Y-90 counts: 1292 cpm

Background counts: 205 / 51.3 cpm Background counts: 205 / 51.3 cpm

Net Tc-99 counts: 2962.7 cpm Net Sr/Y-90 counts: 1240.7 cpm

Comments:

4π Efficiency for Tc-99 Source: 17 % 4π Efficiency for Sr/Y-90 Source: 33 %

Efficiency = Net source counts (cpm) / Source activity (cpm.dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

B

Efficiency Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-94 Serial No: PR255 40 #4

Counter Mfg.: Ludlum Model: 2221 Serial No: 218587

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. 481-3 • Calibration of Radiation Detection Instruments & Devices

GM tube voltage: 900 volts Counter Threshold Setting: 40 mV

Cable Length: ☐ 39 inch. ☐ 5 foot. ☑ Other: Cable

Detector geometry to source: ☑ Face. ☐ Planchett/In tray. ☐ Side. ☐ Other:

Distance to source: ☑ Contact. ☐ Planchett/In tray. ☐ 6 Inches. ☐ Other:

Source: ☑ Tc99 @ 17,800 dpm (1/15/07) sn: 4099-03 ☑ Other: SrY-90 #5443-05 3750 dpm @ 01/15/07

Gross Tc-99 counts: 3060 cpm Gross Sr/Y-90 counts: 1150 cpm

Background counts: 205/51.3 cpm Background counts: 205/51.3 cpm

Net Tc-99 counts: 3008.7 cpm Net Sr/Y-90 counts: 1098.7 cpm

Comments:

4π Efficiency for Tc-99 Source: 17 % 4π Efficiency for Sr/Y-90 Source: 29 %

Efficiency = Net source counts (cpm) / Source activity (cpm,dpm)

Calibrated By: Calibration Date: 7-13-07

Calibration Due: 7-13-08

Reviewed By: Date: 7/13/07

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 6233
P.O.# 1093

Description of Standard:

Model No. DNS-14 Serial No. 5442-05 Isotope SrY-90

Electroplated on polished Ni disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 4002-02.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

3,050 ± 122

The total disintegration rate (dpm) assuming 40 % backscatter of beta particles from the surface of the disc, was:

4,370 ± 174 (0.00197 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Representative:

Calibration Date: 3-28-2005 Reviewed Date: 032805

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

Leak Test for Sr/Y-90
Serial # 5442-05

Counter & Standard				
	Model	2929	Serial No.	147736
	Model	43-10-1	Serial No.	PR150788
Background:	**Background Counts**		2624	
	Background Count Time		60	min
	Standard Source:	Tc-99	Serial No.	4099-03
	Activity	17800	dpm	
	Assay Date	01/15/07	mm/dd/yy	
	Elapsed Time(yrs)	0.4	years	
	Current Activity	17799.93	dpm	

Efficiency			
	Source Counts	2969	cpm
	Source Count Time	1	min
	Efficiency	0.16	cpm/dpm

Leak Test Data	
Test Date (mm/dd/yy)	6/28/07
Isotope Half Life (years)	213000
Sample Counts (beta)	652
Sample Count Time (min)	10
Net sample count rate (cpm)	21.46666667
Net sample activity (dpm)	130.6228492
MDA (dpm)	46.9
MDA (μCi)	0.000021

$$A_2 = A_1 \times e^{\frac{0.693*(-\Delta T)}{HL}}$$

$$MDA_{CPM} = \frac{2.71 + 3.29[RbTs(1 + Ts/Tb)]^{1/2}}{EKTs}$$

$$MDA_{\mu Ci} = MDA_{CPM} / 2.22E+6$$

Leak Test Results Are ≤ MDA (0.0007 μCi)

Leak Test Performed By: _____ Date: 28JUN07

Leak Test Reviewed By: _____ Date: 6/28/07