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*Radionuclide Concentrations in Honey Bees
from Area G at TA-54 during 1997*

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Edited by Hector Hinojosa, Group CIC-1

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*Radionuclide Concentrations in Honey Bees
from Area G at TA-54 during 1997*

T. K. Haarmann
P. R. Fresquez

RADIONUCLIDE CONCENTRATIONS IN HONEY BEES FROM AREA G AT TA-54 DURING 1997

T.K. Haarmann and P.R. Fresquez

ABSTRACT

Honey bees were collected from two colonies located at Los Alamos National Laboratory's Area G, Technical Area 54, and from one control (background) colony located near Jemez Springs, NM. Samples were analyzed for the following: cesium (^{137}Cs), americium (^{241}Am), plutonium (^{238}Pu and $^{239,240}\text{Pu}$), tritium (^3H), total uranium, and gross gamma activity. Area G sample results from both colonies were higher than the upper (95%) level background concentration for ^{238}Pu and ^3H .

INTRODUCTION

As part of the ongoing environmental surveillance program at Area G (Fresquez *et al.* 1997a)—a 25.5-ha (63-ac) low-level radioactive waste management and disposal area located on the east end of Mesa del Buey at Technical Area (TA) 54 at Los Alamos National Laboratory (LANL) (Figure 1)—samples of honey bees were collected from beehives during the summer of 1997. Honey bees can be thought of as mobile samplers that efficiently cover a large sample area

and then return to a central location (Bromenshenk 1992). Honey bees forage in an area with a radius as large as 6 km (3.7 mi) and often cover a total area up to 100 square km (39 square mi) Leita *et al.* 1996, Visscher and Seeley 1982). Each hive contains literally thousands of bees, most of whom will forage for nectar, water, pollen, and plant resins, which are all brought back into the hive. During these foraging flights, bees inadvertently contact and accumulate a wide array of pollutants,

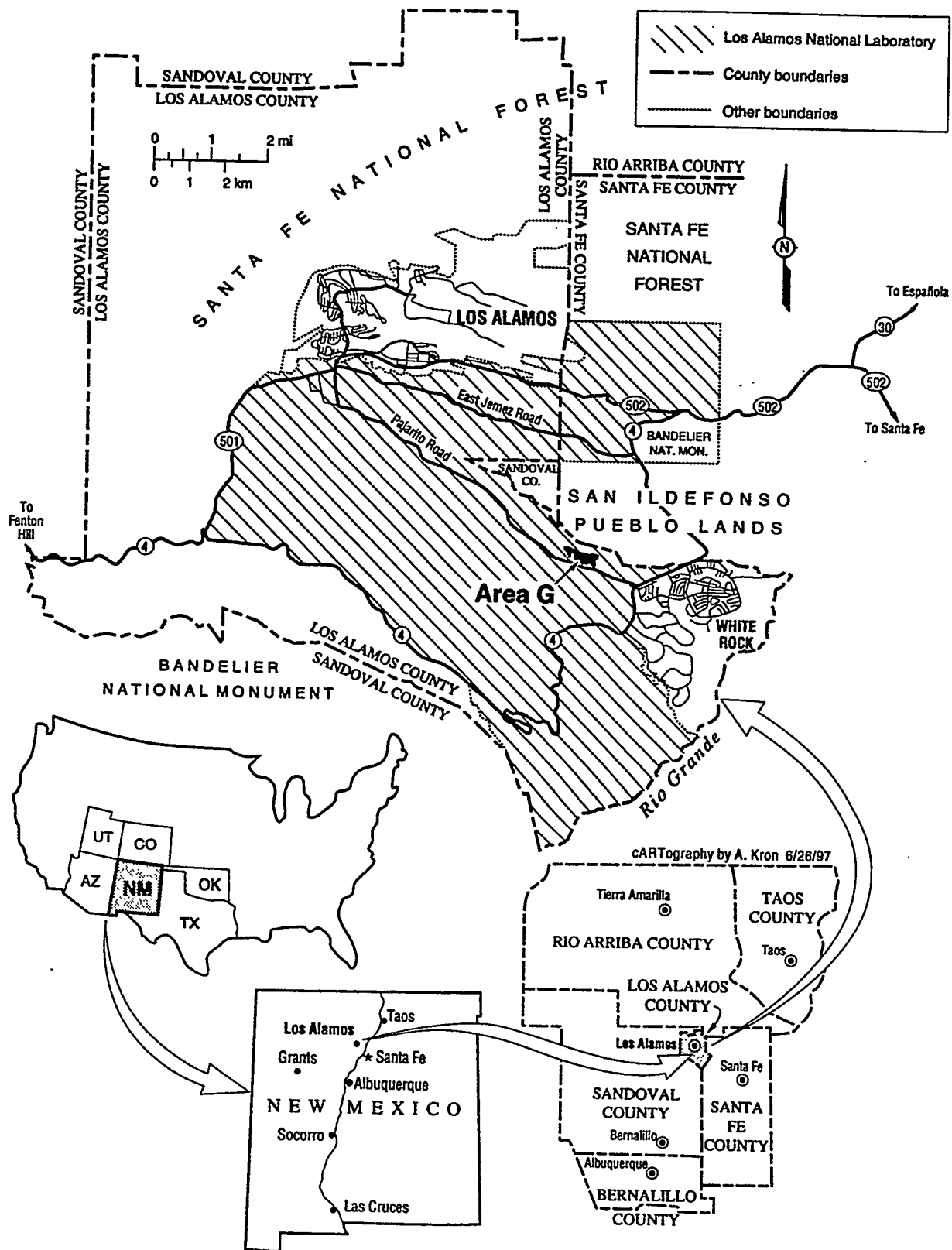


Figure 1. The location of Area G at Los Alamos National Laboratory.

some of which are brought back to the colony (Bromenshenk *et al.* 1985). These contaminants often become incorporated into the bee tissue, the wax, the honey, or the hive itself (Wallwork-Barber *et al.* 1982).

Honey bee studies have been conducted on many different types of pollutants including fluoride (Bromenshenk *et al.* 1988a, Mayer *et al.* 1988), lead (Migula *et al.* 1989), zinc (Bromenshenk *et al.* 1988b), nickel (Balestra *et al.* 1992), potassium (Barbattini *et al.* 1991), cesium (Bettoli *et al.* 1987, Tonelli *et al.* 1990), tritium (White *et al.* 1983, Fresquez *et al.* 1997b), and plutonium (Hakonson and Bostick 1976). It is an inexpensive form of monitoring, especially considering the many different sampling points the foraging bees visit. Collection of bees at one location (the hive) can provide a plethora of information from numerous points concerning the distribution and bioavailability of contaminants. Comparing the amounts of contaminants in honey bees with the known amounts of contaminants in the surrounding area could be useful for modeling the redistribution of contaminants through

ecosystems. The very nature of honey bee ecology makes them an excellent living system from which to monitor the presence of contaminants.

The objective of this study was to compare various radionuclide concentrations in honey bees from Area G with honey bees collected from a background location.

METHODS

We monitored Area G using beehives consisting of a standard Langstroth hive stocked with Italian honey bees (*Apis mellifera ligustica*). During 1997, two colonies were established on the south end of Area G near the ^3H shafts (Figure 2). These colonies were brought into the study site from an uncontaminated area. In addition, a control (background) site with one colony was established 10 km (6 mi) south of Jemez Springs, NM.

After three months, bee tissue samples were collected from all of the colonies. Three separate samples (one from each colony), each containing approximately 100 g of bees, were collected. Each individual 100-g sample consisted of approximately 1,000 bees.

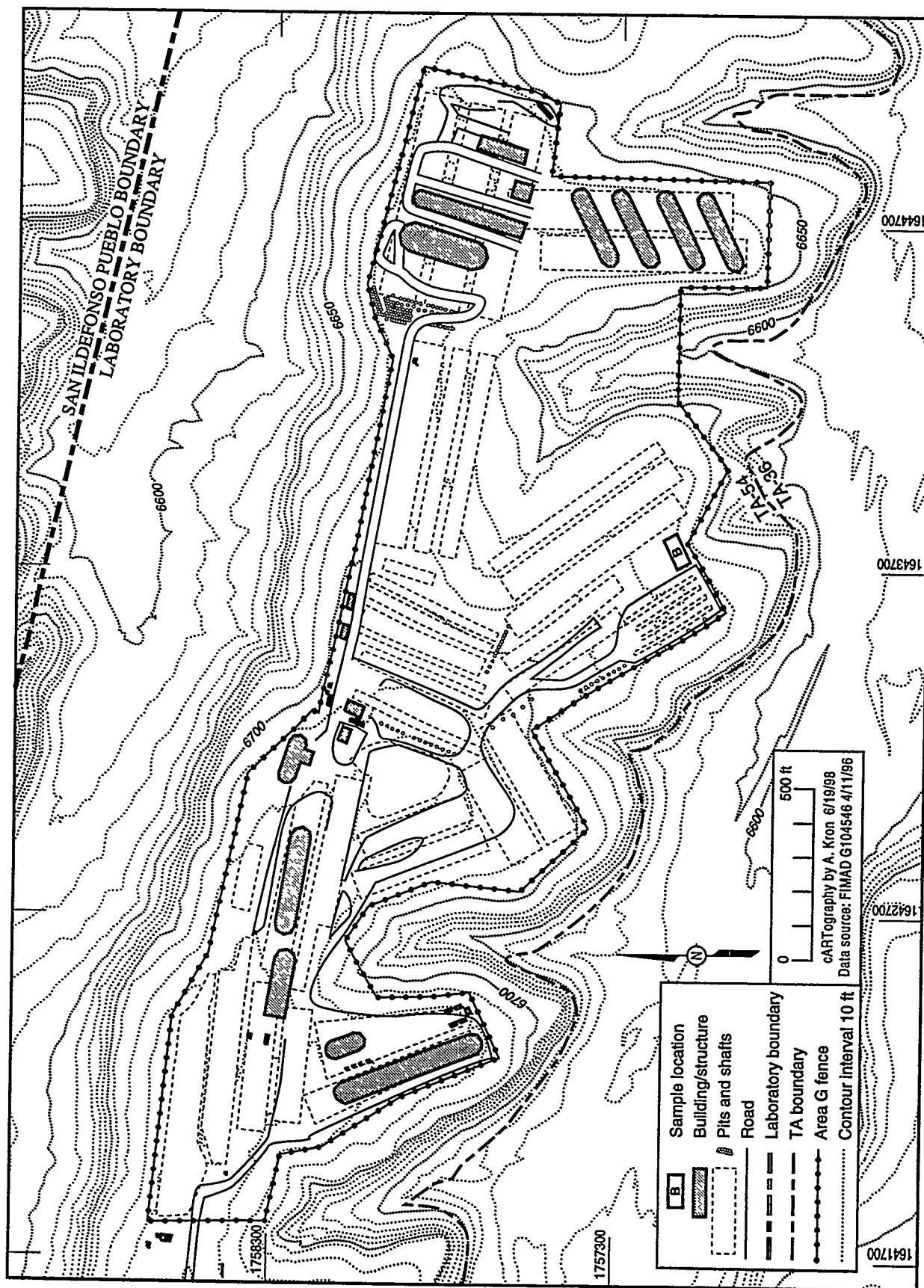


Figure 2. Site/sample location of bee hives at Area G.

Bee samples were collected using a small, rechargeable vacuum. Bees were vacuumed off frames that were removed from the honey supers, transferred to a plastic resealable bag, weighed, and double bagged into plastic resealable bags. All samples were kept in a cooler and frozen upon returning to the laboratory. With each sample collected, the vacuum collection area was thoroughly cleaned to avoid cross-contamination of samples.

All samples were analyzed by LANL's Environmental Chemistry Group for ^3H , ^{137}Cs , ^{241}Am , ^{238}Pu , $^{239,240}\text{Pu}$, total uranium, and gamma activity. Analytical methods have been previously described in Fresquez *et al.* (1997a). The bee tritium samples were analyzed by liquid scintillation counting in the following manner: 5 ml of moisture were distilled from each sample, mixed with 15 ml of a scintillation solution, and counted on a scintillation counter for 50 minutes. All gamma-emitting radionuclide concentrations were determined using high-resolution germanium detector gamma-ray spectrometry. Pu and Am samples were dissolved in nitric acid, isolated by

anion exchange, electroplated onto stainless steel disks and counted using an alpha spectrometer. Total uranium was determined by kinetic phosphorescence analysis.

RESULTS

Table 1 contains a summary of the analytical results from samples collected near Area G and the control site. The original analytical reports are included in Appendix A for future reference. In general, most radionuclides, with the exception of ^{238}Pu and ^3H , were within or just above the regional statistical reference level (RSRL). The RSRL is the upper (95%) level background concentration (mean + two std dev) from the present data. And, of these two radionuclides (^{238}Pu and ^3H), only ^3H concentrations were at detectable levels—where the analytical result was higher than two times the counting uncertainty. Tritium levels in the Area G bees, for example, were at 82.8 and 110.20 pCi mL⁻¹; the control colony contained only 1.03 pCi mL⁻¹. These data are consistent with other surveillance studies of ^3H (and other radionuclides) at Area G in bees

(Fresquez *et al.* 1997b), soils (Conrad *et al.* 1996, Fresquez *et al.* 1997c), small mammals (Biggs *et al.* 1997), and vegetation (Fresquez *et al.* 1997c).

ACKNOWLEDGMENT

Thanks to Rebecca J. Wechsler, Environmental Coordinator, EM-SWO, for technical assistance at Area G.

Table 1. Analytical Results from Honey Bee Samples Collected from Colonies at Area G and a Control Site in 1997.

Element/ Activity	Units	Area G		Area G		Control	AU	RSRL ^b
		C-1	AU ^a	C-2	AU			
¹³⁷ Cs	pCi/g ^c	0.52	0.78	0.86	0.29	-0.33	1.81	3.29
U-total	µg/g ^c	0.18	0.02	0.13	0.01	0.13	0.01	0.15
²⁴¹ Am	pCi/g ^c	0.0329	0.0075	0.0234	0.0058	0.0165	0.0067	0.0299
²³⁸ Pu	pCi/g ^c	0.0026	0.0039	0.0021	0.0034	-0.0089	0.0024	-0.0041
^{239,240} Pu	pCi/g ^c	0.0113	0.0060	0.0020	0.0027	0.0095	0.0050	0.0195
³ H	pCi/mL ^d	82.80	3.60	110.20	4.40	1.03	0.75	2.53
Gamma	pCi/g ^c	36.0	16.3	28.9	14.1	16.9	9.3	36.0

^aAnalytical uncertainty; values are the uncertainty in the analytical results at the 65% confidence level (one sigma).

^bRegional Statistical Reference Level; the upper (95%) level background concentration (mean + two sigma) from present control data.

^cUnits are in g per ash.

^dUnits are in mL tissue moisture.

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APPENDIX A

CST ANALYTICAL REPORTS OF RADIONUCLIDES IN BEES

LOS ALAMOS NATIONAL LABORATORY
CST Analytical Chemistry
Analytical Results Report

Submission Id : 100023448

Method Area: EH-GAMMA

Requester Name: Requester Group:	TIM HAARMANN ESH-20	Customer Cost Code: Logged Date:	7C20WE6A1000 23-OCT-97	Due Date: Screening Data:	23-DEC-97 NO SCREENING DATA REQUIRED
Mail Stop: Requester Phone: Requester Fax #:	M887 667-5019	Study: Analytical Service Agreement #:	ESH20 BIOLOGICALS	Logged by:	LBRANCH

CUSTOMER SAMPLES

Method	Sample Id	Task Id	Customer Id	Component	Result Value	Uncertainty	Units	Qualifier
GENERIC GAMMA	200043493	300118357	G1-97	CS-137	0.52	0.78	pCi/g	
	200043494	300118366	G2-97	CS-137	0.86	0.29	pCi/g	
	200043497	300118386	C1-97	CS-137	-0.33	1.81	pCi/g	

DUPLICATE TASKS

None run for this submission

SAMPLE SPIKES

None run for this submission

**** FINAL REPORT ****

Method Area: EH-GAMMA

Submission Id: 100023448

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

Customer Id	Task Id	Component	Result Value	Uncertainty	Units pCi/g	Qualifier	QC Value	QC Uncertainty	QC units pCi/g	QC Evaluation
00.22785	300143215	CS-137	-0.00	1.80			0.0	0.0		UNDER CONTROL

OPEN QC

Customer Id	Task Id	Component	Result Value	Uncertainty	Units pCi/g	Qualifier	QC Value	QC Uncertainty	QC units pCi/g	QC Evaluation
00.33987	300143216	CS-137	4.87	0.54			4.8000	0.1600		UNDER CONTROL

***** FINAL REPORT *****

A-2

Submission Id : 100023448

Method Area: EH-GAMMA


Analyst

Review


Team Leader

NK
QA Officer

3/26/98
Date

3/26/98
Date

3/26/98
Date

3/27/98
Date

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, LA-12790-MS, Vol I, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

**** FINAL REPORT ****

5418

Method Area: EH-ALPHA

Submission Id : 100023448

Requester Name: TIM HAARMANN
Requester Group: ESH-20
Mail Stop: M887
Requester Phone: 667-5019
Requester Fax #:

Customer Cost Code: 7C20WE6A1000
Logged Date: 23-OCT-97

Due Date: 23-DEC-97
Screening Data: NO SCREENING DATA REQUIRED

Study: ESH20 BIOLOGICALS

Logged by: LBRANCH

Analytical Service Agreement #:

CUSTOMER SAMPLES

Method	Sample Id	Task Id	Customer Id	Component	Result Value	Uncertainty	Units	Qualifier
GENERIC KPA	200043493	300118354	G1-97	U	0.18	0.02	ug/g	
	200043494	300118363	G2-97	U	0.13	0.01	ug/g	
	200043497	300118391	C1-97	U	0.13	0.01	ug/g	

DUPLICATE TASKS

None run for this submission

SAMPLE SPIKES

None run for this submission

***** FINAL REPORT *****

81739

Method Area: EH-ALPHA

Submission Id : 100023448

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

Customer Id	Task Id	Component	Result Value	Uncertainty	Units ug/g	Qualifier	QC Value	QC Uncertainty	QC units ug/g	QC Evaluation UNDER CONTROL
00.22784	300143686	U	0.00	0.01	ug/g		0	0		

OPEN QC

Customer Id	Task Id	Component	Result Value	Uncertainty	Units ug/L	Qualifier	QC Value	QC Uncertainty	QC units ug/L	QC Evaluation UNDER CONTROL
00.38058	300143685	U	10.78	1.08	ug/L		10.1	1.0		

A-5

***** FINAL REPORT *****

Method Area: EH-ALPHA

Submission Id : 100023448

ml
Analyst

Eng
Review

bs
Team Leader

NK
QA Officer

3/31/98
Date

4-1-98
Date

4/1/98
Date

04/02/98
Date

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, LA-12790-MS, Vol I, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

**** FINAL REPORT ****

LOS ALAMOS NATIONAL LABORATORY
CST Analytical Chemistry
Analytical Results Report

13 Apr 1998 15:03

Page 1 of 4

Submission Id : 100023448

Method Area: EH-ALPHA

Requester Name: Requester Group:	TIM HAARMANN ESH-20	Customer Cost Code: Logged Date:	7C20WE6A1000 23-OCT-97	Due Date: Screening Data:	23-DEC-97 NO SCREENING DATA REQUIRED
Mail Stop: Requester Phone: Requester Fax #:	M887 667-5019	Study: Analytical Service Agreement #:	ESH20 BIOLOGICALS	Logged by:	LBRANCH

CUSTOMER SAMPLES

Method	Sample Id	Task Id	Customer Id	Component	Result Value	Uncertainty	Units	Qualifier
AM RAS ENV	200043494	300118359	G1-97	Am-241	0.0329	0.0075	pCi/g	
			G1-97	Am-243T Spike	1.95		pCi	
			G1-97	Am-243T Recovery	56.25		%	
			G1-97	Am-243T Recovered	1.1		pCi	
			G1-97	Am-241 Gross Counts	31		counts	
			G1-97	Am-241 Background Counts	6.2		counts	
			G1-97	Efficiency	19.94		%	
			G1-97	Count Time	3000.00		min	
			G1-97	Analysis Date	04/08/98		MM/DD/YY	
			G1-97	Instrument	ALPHA 80		NONE	
			G2-97	Am-241	0.0234		pCi/g	
			G2-97	Am-243T Spike	1.95		pCi	
			G2-97	Am-243T Recovery	58.33		%	
			G2-97	Am-243T Recovered	1.14		pCi	
			G2-97	Am-241 Gross Counts	24		counts	
			G2-97	Am-241 Background Counts	3.8		counts	
			G2-97	Efficiency	19.02	0.0058	%	
			G2-97	Count Time	3000.00		min	
			G2-97	Analysis Date	04/08/98		MM/DD/YY	

**** FINAL REPORT ****

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A-7

Method Area: EH-ALPHA

Submission Id : 100023448

<u>Method</u>	<u>Sample Id</u>	<u>Task Id</u>	<u>Customer Id</u>	<u>Component</u>	<u>Result Value</u>	<u>Uncertainty</u>	<u>Units</u>	<u>Qualifier</u>
AM RAS ENV	200043494	300118368	G2-97	Instrument	ALPHA 80		NONE	
	200043497	300118388	C1-97	Am-241	0.0165	0.0067	pCi/g	
			C1-97	Am-243T Spike	1.95		pCi	
			C1-97	Am-243T Recovery	43.39		%	
			C1-97	Am-243T Recovered	0.85		pCi	
			C1-97	Am-241 Gross Counts	10		counts	
			C1-97	Am-241 Background Counts	2.2		counts	
			C1-97	Efficiency	20.24		%	
			C1-97	Count Time	3000.00		min	
			C1-97	Analysis Date	04/08/98		MM/DD/YY	
			C1-97	Instrument	ALPHA 80		NONE	

DUPLICATE TASKS

None run for this submission

SAMPLE SPIKES

None run for this submission

**** FINAL REPORT ****

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13-Apr-1998 15:03

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Submission Id : 100023448

Method Area: EH-ALPHA

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

None run for this submission

OPEN QC

None run for this submission

A-9

**** FINAL REPORT ****

7/09/12

Method Area: EH-ALPHA

Submission Id : 100023448

<u>CEA</u>	<u>Evo</u>	<u>63</u>	<u>NJK</u>
Analyst	Review	Team Leader	QA Officer
<u>4/13/98</u>	<u>4-14-98</u>	<u>4/14/98</u>	<u>04/14/98</u>
Date	Date	Date	Date

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceeding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, I.A-12790-MS, Vol I, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

**** FINAL REPORT ****

Q of 12

LOS ALAMOS NATIONAL LABORATORY
CST Analytical Chemistry
Analytical Results Report

06 Apr 1998 15 11

Submission Id : 100023448

Method Area: EH-ALPHA

Requester Name: Requester Group:	TIM HAARMANN ESH-20	Customer Cost Code: Logged Date:	7C20WE6A1000 23-OCT-97	Due Date: Screening Data:	23-DEC-97 NO SCREENING DATA REQUIRED
Mail Stop: Requester Phone: Requester Fax #:	M887 667-5019	Study: Analytical Service Agreement #:	ESH20 BIOLOGICALS	Logged by:	LBRANCH

CUSTOMER SAMPLES

Method	Sample Id	Task Id	Customer Id	Component	Result Value	Uncertainty	Units	Qualifier
PU RAS ENV	200043493	300118358	G1-97	Pu-238	0.0026	0.0039	pCi/g	
			G1-97	Pu-239	0.0113	0.0060	pCi/g	
			G1-97	Pu-242T Spike	1.95		pCi	
			G1-97	Pu-242T Recovery	33.47		%	
			G1-97	Pu-242T Recovered	0.65		pCi	
			G1-97	Pu-238 Gross Counts	6		counts	
			G1-97	Pu-238 Background Counts	4.2		counts	
			G1-97	Pu-239 Gross Counts	15		counts	
			G1-97	Pu-239 Background Counts	7.2		counts	
			G1-97	Efficiency	30.54		%	
			G1-97	Count Time	3000.00		min	
			G1-97	Analysis Date	04/2/98		MM/DD/YY	
			G1-97	Instrument	ALPHA 32		NONE	
			G2-97	Pu-238	0.0021	0.0034	pCi/g	
			G2-97	Pu-239	0.0020	0.0027	pCi/g	
			G2-97	Pu-242T Spike	1.95		pCi	
			G2-97	Pu-242T Recovery	46.78		%	
			G2-97	Pu 242T Recovered	0.91		pCi	
			G2-97	Pu-238 Gross Counts	10		counts	

**** FINAL REPORT ****

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A-11

Submission Id : 100023448

Method Area: EH-ALPHA

<u>Method</u>	<u>Sample Id</u>	<u>Task Id</u>	<u>Customer Id</u>	<u>Component</u>	<u>Result Value</u>	<u>Uncertainty</u>	<u>Units</u>	<u>Qualifier</u>
PLI RAS ENV	200043494	300118367	G2-97	Pu-238 Background Counts	7.6		counts	
			G2-97	Pu-239 Gross Counts	8		counts	
			G2-97	Pu-239 Background Counts	5.8		counts	
			G2-97	Efficiency	30.81		%	
			G2-97	Count Time	3000.00		min	
			G2-97	Analysis Date	04/2/98		MM/DD/YY	
			G2-97	Instrument	ALPHA 32		NONE	
	200043497	300118387	C1-97	Pu-238	-0.0089	0.0024	pCi/g	
			C1-97	Pu-239	0.0095	0.0050	pCi/g	
			C1-97	Pu-242T Spike	1.95		pCi	
			C1-97	Pu-242T Recovery	40.20		%	
			C1-97	Pu-242T Recovered	0.78		pCi	
			C1-97	Pu-238 Gross Counts	2		counts	
			C1-97	Pu-238 Background Counts	8.0		counts	
			C1-97	Pu-239 Gross Counts	11		counts	
			C1-97	Pu-239 Background Counts	4.6		counts	
			C1-97	Efficiency	31.12		%	
			C1-97	Count Time	3000.00		min	
			C1-97	Analysis Date	04/2/98		MM/DD/YY	
			C1-97	Instrument	ALPHA 32		NONE	

DUPLICATE TASKS

None run for this submission

***** FINAL REPORT *****

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A-12

06-Apr-1998 15:11

Page 3 of 5

Method Area: EH-ALPHA

SAMPLE SPIKES

Submission Id : 100023448

None run for this submission

A-13

**** FINAL REPORT ****

7 4 13

Method Area: EH-ALPHA

Submission Id : 100023448

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

None run for this submission

OPEN QC

None run for this submission

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**** FINAL REPORT ****

Q of 13

Method Area: EH-ALPHA

Submission Id : 100023448

CEH/A
Analyst

Eoy
Review

GB
Team Leader

NK
QA Officer

4/6/98
Date

4-7-98
Date

4/7/98
Date

04/07/98
Date

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, LA-12790-MS, Vol I, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

**** FINAL REPORT ****

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Method Area: EH-ALPHA

Submission Id : 100023448

Requester Name:	TIM HAARMANN	Customer Cost Code:	7C20WE6A1000	Due Date:	23-DEC-97
Requester Group:	ESH-20	Logged Date:	23-OCT-97	Screening Data:	NO SCREENING DATA REQUIRED
Mail Stop:	M887	Study:	ESH20 BIOLOGICALS	Logged by:	LBRANCH
Requester Phone:	667-5019	Analytical Service Agreement #:			
Requester Fax #:					

CUSTOMER SAMPLES

Method	Sample Id	Task Id	Customer Id	Component	Result Value	Uncertainty	Units	Qualifier
II-3 LS ENV	200043493	300118355	G1-97	H-3	82800	3600	pCi/L	
			G1-97	H-3 MDA	450		pCi/L	
	200043494	300118364	G2-97	H-3	110200	4400	pCi/L	
			G2-97	H-3 MDA	450		pCi/L	
	200043497	300118392	C1-97	H-3	1030	750	pCi/L	
			C1-97	H-3 MDA	450		pCi/L	

2000000

DUPLICATE TASKS

None run for this submission

SAMPLE SPIKES

None run for this submission

***** FINAL REPORT *****

Method Area: EH-ALPHA

Submission Id : 100023448

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

None run for this submission

OPEN QC

None run for this submission

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9000000

**** FINAL REPORT ****

Method Area: EH-ALPHA

Submission Id : 100023448

Aje
Analyst

BS
Review
for file

BS
Team Leader

may
QA Officer

2/27/98
Date

2/27/98
Date

2/27/98
Date

3/4/98
Date

2000007

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, LA-12790-MS, Vol 1, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

***** FINAL REPORT *****

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Submission Id : 100023448

Method Area: EH-GAMMA

***** CST QUALITY ASSURANCE REPORT *****

BLIND QC

None run for this submission

METHOD BLANKS

Customer Id	Task Id	Component	Result Value	Uncertainty	Units pCi/g	Qualifier	QC Value	QC Uncertainty	QC units pCi/g	QC Evaluation
00.22776	300140432	Gamma	0.1	0.2			0.0	0.0		UNDER CONTROL

OPEN QC

Customer Id	Task Id	Component	Result Value	Uncertainty	Units pCi/g	Qualifier	QC Value	QC Uncertainty	QC units pCi/g	QC Evaluation
00.31809	300140433	Gamma	31.5	3.1			28.8800	0.9500		UNDER CONTROL

**** FINAL REPORT ****

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Method Area: EH-GAMMA

Submission Id : 100023448

Yg
AnalystSD
ReviewCD
Team LeaderNK
QA Officer3/12/98
Date3/12/98
Date3/2/98
Date3/12/98
Date

No Sample Discrepancies Noted by Sample Management Section

The control status of the preceding data was evaluated using the standard statistical criteria set forth in Quality Assurance for Health and Environmental Chemistry: 1992, LA-12790-MS, Vol I, pp. 19-29.

"The reported uncertainties are at the 1 sigma confidence level."

**** FINAL REPORT ****