To Lewis Stu

Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Date: June 2, 1997
In Reply Refer To: ESH-18/WQ&H:97-0165
Mail Stop: K497
Telephone: (505) 665-1859

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NM ENVIRONMENT DEPARTMENT
OFFICE OF THE SECRETARY

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JUN 1997

Mr. Ed Kelly, Ph.D
Director/Acting Bureau Chief
Surface Water Quality Bureau
N. M. Environment Department
P.O. Box 26110
Santa Fe, New Mexico 87502

SUBJECT: ANALYTICAL DATA FROM THE TA-15 CONNECTOR ROAD PROJECT FILL MATERIAL

Dear Mr. Kelly:

Enclosed are the analytical results and the sampling notes from the sampling effort of the TA-15 Connector Road Project. These samples were collected in accordance with the sampling plan submitted on February 7, 1997 and approved on February 28, 1997. Also enclosed is the abstract and introduction to a Laboratory report titled "Natural Background Geochemistry, Geomorphology, and Pedogenesis of Selected Soil Profiles and Bandelier Tuff Los Alamos, New Mexico", LA-12913-MS, May 1996. This LA Report provides some additional information on the natural background parameters at Los Alamos to assist in your review.

If there are any questions please contact me at 665-1859 or Mike Alexander at 665-4752.

Sincerely,

Steven R. Rae
Water Quality and Hydrology Group

SR:MA/tp

Enclosures: TA-15 Connector Road Fill Material Analytical Data
Sampling Notes
LA Report - LA-12913-MS, "Natural Background Geochemistry, Geomorphology, and Pedogenesis of Selected Soil Profiles and Bandelier Tuff Los Alamos, New Mexico" May 1996.

4184

Enclosures: a/s

Cy: G. Saums, NMED/SWQB, Santa Fe, New Mexico, w/enc.
B. Hoditchek, NMED/SWQB, Santa Fe, New Mexico, w/enc.
B. Koch, DOE/LAAO, w/enc., MS A316
B. Day, DX-DO, w/o enc., MS P915
B. Stine, DX-DO, w/o enc., MS P915
M. Montoya, DX-DO, w/o enc., MS P915
T. Alexander, DX-DO, w/o enc., MS P915
A. Cucchiara, DX/FM-ESH-1, w/enc., MS P942
F. Sisneros, DX/FM-ESH-7, w/enc., MS P915
D. Erickson, ESH-DO, w/o enc., MS K491
M. Alexander, ESH-18, w/enc., MS K497
WQ&H File, w/enc., MS K497
CIC-10, w/enc., MS A150

TA-15 Connector Road Fill Material Sampling Effort

Samples Collected on April 30, 1997 by Dustie Stevens, ESH-19 and Mike Alexander, ESH-18.

Ridge Road Fill Material:

Samples Collected at 10:45:

Three samples were collected from three areas of the remaining fill material. These samples were labeled as:

RR-1A, 1B, and 1C
RR-2A, 2B, and 2C
RR-3A, 3B, and 3C

The material sampled consisted of sand and soil mixed with crushed gravel. The fill material at this location is distinguishable from the surrounding soil. There are six grub piles which contain brush, vegetation and rocks removed from the fill pile prior to transport.

TA-15-285 Fill Material:

Samples Collected at 11:30:

Three samples were collected from three areas of the remaining fill material. These samples were labeled as:

15-285-1A, 1B, and 1C
15-285-2A, 2B, and 2C
15-285-3A, 3B, and 3C

The material sampled consisted of soil and crushed tuff with areas of mixed crushed gravel. The fill material at this location is distinguishable from the surrounding soil. There are grub piles which contain brush, vegetation and rocks removed from the fill pile prior to transport.

Samples were transported to TA-59 and sent to an outside laboratory. The six samples were composited from the sets of three and analyzed for the parameters identified in the sampling plan.

ASSAIGAI ANALYTICAL LABORATORIES, INC.
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May 8, 1997 15:27

CERTIFICATE OF ANALYSIS
RESULTS BY SAMPLE

SENT TO: MERRICK & CO
195 EAST ROAD
LOS ALAMOS, NM 87544

ATTN: STEVE VEENIS

WORKORDER # : 9704294
WORK ID : TA-15 CONNECTOR RD. PROJECT
CLIENT CODE : MERR01
DATE RECEIVED : 04/30/97

Lab ID: 9704294-01A
Sample ID: RR 1A,1B,1C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-01B
Sample ID: RR 1A,1B,1C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

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Lab ID: 9704294-01C
Sample ID: RR 1A,1B,1C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	14800	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	8.8	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	7.9	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	10.7	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	8.1	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311
Lead, Pb	12.5	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	31.3	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	30.3	mg/Kg	5.0	1.0	05/05/97	M97311

Lab ID: 9704294-02A
Sample ID: RR 2A,2B,2C

Collected: 04/20/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-02B
Sample ID: RR 2A,2B,2C

Collected: 04/20/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

Lab ID: 9704294-02C
Sample ID: RR 2A,2B,2C

Collected: 04/20/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	18000	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	7.3	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	5.8	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	18.6	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	7.6	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311
Lead, Pb	32.6	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	27.8	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	29.8	mg/Kg	5.0	1.0	05/05/97	M97311

Lab ID: 9704294-03A
Sample ID: RR 3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			

Lab ID: 9704294-03A
Sample ID: RR 3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-03B
Sample ID: RR 3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

Lab ID: 9704294-03C
Sample ID: RR 3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	14000	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	8.1	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	6.0	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	10.7	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	7.1	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311

Lab ID: 9704294-03C
Sample ID: RR 3A,3B,3C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
METALS-ICP/SW846 6010						
Lead, Pb	12.5	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	24.5	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	27.7	mg/Kg	5.0	1.0	05/05/97	M97311

Lab ID: 9704294-04A
Sample ID: 15-285-1A,1B,1C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-04B
Sample ID: 15-285-1A,1B,1C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

Lab ID: 9704294-04C
Sample ID: 15-285-1A,1B,1C
Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311

Lab ID: 9704294-04C
Sample ID: 15-285-1A,1B,1C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	14800	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	8.1	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	4.8	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	8.6	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	5.6	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311
Lead, Pb	11.7	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	17.7	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	26.6	mg/Kg	5.0	1.0	05/05/97	M97311

Lab ID: 9704294-05A
Sample ID: 15-285-2A,2B,2C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-05B
Sample ID: 15-285-2A,2B,2C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

Lab ID: 9704294-05C
Sample ID: 15-285-2A,2B,2C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	18400	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	9.1	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	6.0	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	9.8	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	6.4	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311
Lead, Pb	12.3	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	21.5	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	26.6	mg/Kg	5.0	1.0	05/05/97	M97311

Lab ID: 9704294-06A
Sample ID: 15-285-3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
HMX	ATTACHED	mg/Kg				
RDX	ATTACHED	mg/Kg	0			
1,3,5-Trinitrobenzene	ATTACHED	mg/Kg	0			
Tetryl	ATTACHED	mg/Kg	0			

Lab ID: 9704294-06A
Sample ID: 15-285-3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
EXPLOSIVES/SW846 8330						
1,3-Dinitrobenzene	ATTACHED	mg/Kg	0			
4-Amino-2,6-DNT	ATTACHED	mg/Kg	0			
Nitrobenzene	ATTACHED	mg/Kg	0			
2-Amino-4,6-DNT	ATTACHED	mg/Kg	0			
2,4,6-Trinitrotoluene	ATTACHED	mg/Kg	0			
2,6-Dinitrotoluene	ATTACHED	mg/Kg	0			
2,4-Dinitrotoluene	ATTACHED	mg/Kg	0			
2-Nitrotoluene	ATTACHED	mg/Kg	0			
4-Nitrotoluene	ATTACHED	mg/Kg	0			
3-Nitrotoluene	ATTACHED	mg/Kg	0			

Lab ID: 9704294-06B
Sample ID: 15-285-3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
GROSS ALPHA/GROSS BETA						
Gross Alpha	ATTACHED	pCi/L				
Gross Beta	ATTACHED	pCi/L				
RADIUM 226/228						
Radium 226	ATTACHED	pCi/L				
Radium 228	ATTACHED	pCi/L				
TRITIUM						
Tritium	ATTACHED	pCi/L				

Lab ID: 9704294-06C
Sample ID: 15-285-3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
Boron by EPA 6010						
Boron, B	ND	mg/Kg	15	1.0	05/05/97	M97311
CVAA Hg XT/SW846 7471	05/01/97	N/A				
MERCURY (CVAA)/SW846 7471						
Mercury	ND	mg/Kg	0.15	1.0	05/02/97	M97312
Metal(ICP) DIG /SW846 3050	05/01/97	N/A				
METALS-ICP/SW846 6010						
Silver, Ag	NT	mg/Kg	1.0			M97311
Aluminum, Al	17800	mg/Kg	25	1.0	05/05/97	M97311
Arsenic, As	10.0	mg/Kg	3.0	1.0	05/05/97	M97311
Barium, Ba	NT	mg/Kg	0.50			M97311
Beryllium, Be	NT	mg/Kg	0.50			M97311
Calcium, Ca	NT	mg/Kg	15			M97311
Cadmium, Cd	ND	mg/Kg	0.20	1.0	05/05/97	M97311
Cobalt, Co	5.0	mg/Kg	0.50	1.0	05/05/97	M97311
Chromium, Cr	10.3	mg/Kg	1.0	1.0	05/05/97	M97311
Copper, Cu	6.4	mg/Kg	0.50	1.0	05/05/97	M97311
Iron, Fe	NT	mg/Kg	15			M97311
Potassium, K	NT	mg/Kg	10			M97311
Magnesium, Mg	NT	mg/Kg	10			M97311
Manganese, Mn	NT	mg/Kg	0.25			M97311
Sodium, Na	NT	mg/Kg	15			M97311
Nickel, Ni	NT	mg/Kg	2.0			M97311

Lab ID: 9704294-06C
Sample ID: 15-285-3A,3B,3C

Collected: 04/30/97 10:45:00
Matrix: SOIL

TEST / METHOD	RESULT	UNITS	LIMIT	D_F	DATE ANAL	BATCH_ID
METALS-ICP/SW846 6010						
Lead, Pb	10.6	mg/Kg	2.0	1.0	05/05/97	M97311
Antimony, Sb	NT	mg/Kg	1.5			M97311
Selenium, Se	ND	mg/Kg	2.5	1.0	05/05/97	M97311
Thallium, Tl	NT	mg/Kg	20			M97311
Vanadium, V	21.2	mg/Kg	0.15	1.0	05/05/97	M97311
Zinc, Zn	24.8	mg/Kg	5.0	1.0	05/05/97	M97311

for William P. Biava
President

WORKORDER COMMENTS

DATE : 05/08/97
WORKORDER:

DEFINITIONS/DATA QUALIFIERS

The following are definitions, abbreviations, and data qualifiers which may have been utilized in your report:

ND = Analyte "not detected" in analysis at the sample specific detection limit.
D_F = Sample "dilution factor"
NT = Analyte "not tested" per client request.
B = Analyte was also detected in laboratory method QC blank.
E = Analyte concentration (result) is an estimated value or exceeds analysis calibration range.
LIMIT = The minimum amount of the analyte that AAL can detect utilizing the specified analysis.

Please Note: Multiply the "Limit" value (AAL's Detection Limit) by Dilution Factor (D_F) to obtain the sample specific Detection Limit.

REPORT COMMENTS

GP Work Order # 9705019

SAMPLE ANALYSIS REPORT

Prepared For:

ASSAIGAI ANALYTICAL LABS
7300 JEFFERSON NE
ALBUQUERQUE, NM 87109

97-04-294

Prepared By:

GP Environmental Services, Inc.
202 Perry Parkway
Gaithersburg, MD 20877

May 07, 1997

for Marty Sadoughi, Laboratory Director

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

Project: 97-04-294

ASSAIGAI ANALYTICAL LABS
7300 JEFFERSON NE
ALBUQUERQUE, NM 87109
Atten: Mr. DANIEL J MOORE

GP ENVIRONMENTAL SERVICES
202 Perry Parkway
Gaithersburg, MD 20877

Atten: Client Services
Phone: (301) 926-6802

Certified by:

SAMPLE IDENTIFICATION

GP ID	Client ID
9705019-01A	97-04-294-01A
9705019-02A	97-04-294-02A
9705019-03A	97-04-294-03A
9705019-04A	97-04-294-04A
9705019-05A	97-04-294-05A
9705019-06A	97-04-294-06A

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-01A
Client ID: 97-04-294-01A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-02A
Client ID: 97-04-294-02A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-03A
Client ID: 97-04-294-03A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-04A
Client ID: 97-04-294-04A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-05A
Client ID: 97-04-294-05A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

Project: 97-04-294

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9705019-06A
Client ID: 97-04-294-06A
Collected: 04/30/97
Dilution: 1

Matrix: SOIL
Method: SW-846 8330
Units: ug/Kg

Analyst: YS
Analyzed: 05/07/97
Prepared: 05/05/97

LIQUID CHROMATOGRAPHY TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,3,5-Trinitrobenzene	BQL	40.2	
1,3-Dinitrobenzene	BQL	37.2	
2,4,6-Trinitrotoluene	BQL	35.6	
2,4-Dinitrotoluene	BQL	51.6	
2,6-Dinitrotoluene	BQL	47.6	
2-Amino-4,6-dinitrotoluene	BQL	46.7	
2-Nitrotoluene	BQL	81.4	
3-Nitrotoluene	BQL	81.7	
4-Amino-2,6-dinitrotoluene	BQL	40.8	
4-Nitrotoluene	BQL	87.2	
HMX	BQL	70.5	
Nitrobenzene	BQL	35.2	
RDX	BQL	50.9	
Tetryl	BQL	163	

GP ENVIRONMENTAL SERVICES

Possible notes and definitions for this report:

BQL = Below Quantitation Limit

J = Value is less than the reporting limits but greater than zero

P = Indicates that there is greater than 25% difference for detected pesticide/ Aroclor results between the two GC columns

B = Indicates that the compound was found in the associated blank

E = Indicates that the concentration exceeded the calibration range of the instrument

U = Indicates that the compound was analyzed for but not detected, number indicates the detection limit

D = Indicates that the compound was found in a analysis at a secondary dilution factor

***** = Value obtained from a 1:5 dilution

+ = Value obtained from a 1:10 dilution

= Value obtained from a 1:20 dilution

= = Value obtained from a 1:25 dilution

^ = Value obtained from a 1:50 dilution

~ = Value obtained from a 1:100 dilution

! = Value obtained from a 1:250 dilution

@ = Value obtained from a 1:125 dilution (Medium Level)

$ = Value obtained from a 1:500 dilution

& = Value obtained from a 1:1000 dilution

N = Flashpoint not observed, heated to specified limit

R = Flammable at room temperature

TNTC = Too numerous to count

B.P. = Detection limit taken from boiling point

F.F. = Sample gave off flammable fumes

AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-01B	**ARS Sample I.D.:**	ARS-97-1449
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	19.11	0.86	0.66	pCi/gm	EPA 900M	5/7/97 0638	SB
Ra-226	2.36	0.50	0.19	pCi/gm	EPA 901.1M	5/06/97 0925	SB
Ra-228	1.16	0.15	0.03	pCi/gm	EPA 901.1M	5/06/97 0925	SB
Tritium	239.00	203.00	334.00	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	9.30	0.10	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

ARS AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-02B	**ARS Sample I.D.:**	ARS-97-1450
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	87.64	5.78	4.98	pCi/gm	EPA 900M	5/04/97 0243	SB
Ra-226	2.55	0.64	0.22	pCi/gm	EPA 901.1M	5/06/971053	SB
Ra-228	1.30	0.15	0.03	pCi/gm	EPA 901.1M	5/06/97 1053	SB
Tritium	432	204	318	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	10.7	0.1	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-03B	**ARS Sample I.D.:**	ARS-97-1451
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	32.35	1.42	1.06	pCi/gm	EPA 900M	5/07/97 0638	SB
Ra-226	2.74	0.55	0.20	pCi/gm	EPA 901.1M	5/06/97 1347	SB
Ra-228	1.15	0.10	0.03	pCi/gm	EPA 901.1M	5/06/97 1347	SB
Tritium	153	189	312	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	7.9	0.1	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-04B	**ARS Sample I.D.:**	ARS-97-1452
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	32.46	1.42	1.06	pCi/gm	EPA 900M	5/07/97 0638	SB
Ra-226	2.45	0.69	0.24	pCi/gm	EPA 901.1M	5/06/97 2004	MB
Ra-228	1.35	0.10	0.04	pCi/gm	EPA 901.1M	5/06/97 2004	MB
Tritium	428	211	335	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	9.4	0.1	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

ARS AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
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ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-05B	**ARS Sample I.D.:**	ARS-97-1453
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	48.93	3.76	3.67	pCi/gm	EPA 900M	5/04/97 0243	SB
Ra-226	2.31	0.60	0.23	pCi/gm	EPA 901.1M	5/07/97 0852	SB
Ra-228	1.42	0.12	0.04	pCi/gm	EPA 901.1M	5/07/97 0852	SB
Tritium	180	200	332	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	16.3	0.1	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

ARS Tracking Number:	ARS-97-0406	**P.O. Number:**	97-04-294-SC-AR
Client I.D.:	97-04-244-06B	**ARS Sample I.D.:**	ARS-97-1454
Date Sampled:	4/30/97	**Date Recieved:**	5/02/97
Time Sampled:	1045	**Time Recieved**	1100
Type of Sample:	Solid	**Date of Report**	5/29/97

Analysis Description	Analysis Result	Analysis Error ±2σ	Detection Limit	Analysis Units	Analysis Test Method	Analysis Date & Time	Analysis Technician
Gross Alpha	20.60	1.24	1.20	pCi/gm	EPA 900M	5/07/97 0638	SB
Ra-226	1.81	0.78	0.24	pCi/gm	EPA 901.1M	5/07/97 0957	SB
Ra-228	1.30	0.16	0.03	pCi/gm	EPA 901.1M	5/07/97 0957	SB
Tritium	315	192	304	pCi/L	NR	5/06/97 N/A	*SC
% moisture (104°C)	10.2	0.1	N/A	%	SM 2540G	5/05/97 N/A	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

AMERICAN RADIATION SERVICES, INC.
1726 Wooddale Court • Baton Rouge, Louisiana 70806
1 (800) 401-4277 • Fax (504) 927-6822

Quality Assurance Report

ARS Tracking Number: ARS-97-0406 **P.O. Number:** 97-04-294-SC-AR

Analysis Method(s): EPA 900M, 901.1M, Tritium

Analysis Type	Analysis Sub-Type	Analysis I.D.	Analysis Result	Analysis Error ±2σ	Analysis Units	Expected or Duplicate Value	Analysis Error ±2σ	Analysis Units	% Rec.	Sample Date & Time	Analysis Technician
G. Alpha	D	1450D	93.04	6.77	pCi/gm	87.64	5.78	pCi/gm	106	5/04/97 0243	SB
G. Alpha	D	1453D	37.59	2.11	pCi/gm	48.93	3.76	pCi/gm	77	5/04/97 0243	SB
Ra-226	RS	A5560	38.63	2.77	pCi/gm	39.10	2.70	pCi/gm	99	5/06/97 1235	SB
Ra-226	RS	A5560	37.38	2.34	pCi/gm	39.10	2.70	pCi/gm	96	5/07/97 0740	SB
Ra-226	RS	A5560	40.15	2.81	pCi/gm	39.10	2.70	pCi/gm	103	5/07/97 1846	MB
Tritium	RS	LCS	18.40	N/A	pCi/L	21.50	N/A	pCi/L	86	5/06/97 1323	*SC

Quality Assurance Review

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.
2.0) The data in this report are within the limits of uncertainty specified in the reference method unless specified.
3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix.
4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B
5.0) Total activity is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.
6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228. (Gamma Spectroscopy only)
7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234. (Gamma Spectroscopy only)
8.0) All Gamma spectroscopy was performed utilizing high purity germanium detectors (HPGE).

Method References:

1.0) EPA 600/4-80-032, Prescribed Procedures for the Measurement of Radioactivity in Drinking Water, August 1980.
2.0) Standard Methods for the Examination of Water and Waste Water, 18th, 1992
3.0) EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995)
4.0) EPA 600/4/79-020, Methods for Chemical Analysis of Water and Waste, March 1983.
5.0) HASL 300

Definitions:

1.0)	BDL	Analyte not detected because the value was below the detection limit.
2.0)	ND	Not detected above the detection limit.
3.0)	Detection Limit	The minimum amount of the analyte that ARS can detect utilizing the specific analysis.
4.0)	B	Method Blank
5.0)	D	Method Duplicate
6.0)	MS	Matrix Spike
7.0)	S	Spike
8.0)	RS	Reference Spike
9.0)	*SC	Subcontracted out to another qualified laboratory
10.0)	NR	Not Referenced

Notes: American Radiation Services, Inc assumes no liability for the use or interpretation of any analytical results provided other than the cost of the performed analysis itself. Reproduction of this report in less than full requires the written consent of the client.

LA-12913-MS

c. 6

Natural Background Geochemistry, Geomorphology, and Pedogenesis of Selected Soil Profiles and Bandelier Tuff Los Alamos, New Mexico

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Natural Background Geochemistry, Geomorphology, and Pedogenesis of Selected Soil Profiles and Bandelier Tuff Los Alamos, New Mexico

by

Patrick A. Longmire, Steven L. Reneau, Paula M. Watt, Leslie D. McFadden, Jamie N. Gardner, Clarence J. Duffy, and Randall T. Ryti

ABSTRACT

During 1992 and 1993, the Bandelier Tuff and several soil profiles were sampled to determine background elemental concentrations for Los Alamos National Laboratory (hereafter referred to as the Laboratory). Soil samples were incompletely digested using HNO_3 at pH 1 before chemical analyses, which provided partial element concentrations in solid phases. Soil and Bandelier Tuff samples were also analyzed by instrumental neutron activation analysis and delayed neutron activation analysis to determine total element concentrations. These soil digestion procedures provide a comparison of elements incorporated within the primary minerals (total digestion) with those elements concentrated in surface coatings (partial digestion), including clay minerals, iron oxides, amorphous ferric hydroxide, and ferric oxyhydroxide. Additional analytical methods consisted of inductively coupled plasma spectroscopy, atomic absorption, x-ray fluorescence, and ion chromatography.

Soils present on the Pajarito Plateau are extremely variable in physical and chemical properties such as particle size, percent calcium carbonate, clay mineralogy, iron oxides, and trace-element chemistry. Soils have higher concentrations of aluminum, arsenic, barium, calcium, cerium,

cobalt, chromium, and iron than in the Bandelier Tuff samples. The Bandelier Tuff has higher concentrations of beryllium, lead, sodium, potassium, thorium, and uranium than the soils. Higher concentrations of trace elements are found in well-developed soils than in the weakly developed soils found on the Pajarito Plateau. Clay minerals and iron oxides, which have relatively high surface areas, occur within B horizons and control trace-element distributions in soils. The B horizons contain higher concentrations of trace elements relative to A and C horizons. Variations in soil-element concentrations are also affected by climate, topography, and the parent materials, which include alluvial fans, sheet wash material, colluvium, wind-blown sediment, El Cajete pumice, and the Bandelier Tuff.

Because background-element concentrations in soils forming on the Pajarito Plateau vary with parent material, the degree of soil development, and other factors, site-specific conditions must be considered to select the most appropriate samples. The results of chemical analyses discussed in this report represent the most appropriate (noncontaminated) published chemical data available to establish background-elemental distributions in soils throughout the Laboratory.

Comparisons of site and background data are needed as part of the Resource Conservation and Recovery Act corrective action process developed by the US Environmental Protection Agency. The upper tolerance limit (UTL) is equal to the mean plus the standard deviation multiplied by k-factors (one-sided normal factors), using the 99th percentile at 95% confidence. This report contains UTL values for different elements (metals and nonmetals) in soils. In this initial data set, soils horizons are grouped together to make it possible to calculate an UTL value for each element. Values of UTL in soils for naturally occurring radioisotopes of potassium, thorium, and uranium at the Laboratory are also presented in this report. Additional statistical analyses, including calculation of a horizon-specific UTL for each element, will be performed as more background-element data are collected for soils. Site data greater than the UTL-calculated threshold value are considered to exceed the normal maximum background concentration for a particular element. Because of the limited number of Bandelier Tuff and soil samples collected, this initial data set is not necessarily representative of the full suite of soils and tuff present at the Laboratory and may not include the full range of natural concentrations for all elements and species. However, additional Bandelier Tuff and soil samples continue to be collected and will be included in the Laboratory-wide background database.

INTRODUCTION

To determine the environmental impact of Los Alamos National Laboratory's activities on surface waters, groundwaters, soils, sediments, and Bandelier Tuff requires thorough knowledge of the background-element chemistry for both geological and hydrological media. Background media are defined as soils, sediments, rocks, surface waters, and groundwaters unaffected by Laboratory operations. Background element concentrations in soils and the Bandelier Tuff are presented in this report; element and solute distributions within sediments, surface waters, and groundwaters will be addressed in future studies. Statistical and geochemical comparisons of background samples and contaminated or nonbackground samples are needed to identify and evaluate environmental contamination.

During the spring and summer of 1992 and 1993, the Bandelier Tuff and several soil profiles were characterized and sampled to determine background-element concentrations (Longmire *et al.*, 1993; Watt and McFadden, 1992). During this time, 38 samples of the Bandelier Tuff and 75 soil samples were submitted for chemical analyses. Soil samples were analyzed for both total element and partial element concentrations, using hydrofluoric acid(HF)-neutron activation and nitric acid (HNO_3), respectively. However, the Bandelier Tuff samples were only analyzed for total element concentrations. Because of the geochemical variability of soils and Bandelier Tuff as well as the limited number of samples analyzed, this data set is not necessarily representative of the full suite of soils and Bandelier Tuff present at the Laboratory and may not include the full range of natural concentrations for all elements.

Geochemical characteristics of soils on the Pajarito Plateau vary widely and are related to local variations in parent material, topography, soil age, surficial processes, climate, and vegetation. As part of the Laboratory-wide background geochemical characterization, sites were chosen for detailed soil sampling and analysis to provide a partial selection of the wide range of soil-geomorphic settings occurring at the Laboratory. The geomorphic setting of each sample site was carefully described to provide a better understanding of the variations in soil characteristics. With additional background-element data to be collected in the future, it will be possible to relate the geochemical characteristics at a site to the geomorphic setting and accomplish reasonable extrapolation of the soils data.

This investigation is relevant to the Environmental Restoration (ER) Project, because background-element concentrations are used in conjunction with screening action levels (SALs) in risk-assessment calculations for different contaminants. These background-element data are also necessary to develop sampling and remediation strategies for sites, to understand processes controlling contaminant transport, and to distinguish between contaminated and noncontaminated media. These data may also be used to establish cleanup levels for sites that will be remediated in the future.

The goal of the ER Project Laboratory background study described in this report is to provide natural background-element data on soils and Bandelier Tuff

at the Laboratory. This report

(1) summarizes results of soil characterization conducted by Watt and McFadden (1992),

(2) describes analytical and statistical methods used to define and characterize background chemical (analyte) distributions in soils and Bandelier Tuff,

(3) discusses soil development (pedogenesis) and soil chemistry relationships, and

(4) describes how these background data may be statistically compared to nonbackground (potential release site) or contaminant analytical data.

In addition, this report addresses characterization studies outlined in the Laboratory's Hazardous and Solid Waste Amendments (HSWA) permit, Task III (Facility Investigation), Section A (Environmental Setting) 2 (Soils), Items a, b, f, g, i, k, l, m, p, and q.

Sampling sites for this study were selected both within and around the perimeter of the Laboratory to provide the most representative locations of the Laboratory's background environment. Soil samples were collected within trenches, from sides of drainages, and along roadcuts exposed within and around the perimeter of the Laboratory—generally upwind from any potential air-borne contamination—as well as from different depths within various soil horizons. Fresh samples of Bandelier Tuff were collected in Frijoles Canyon immediately south of the Laboratory, an excellent location for Laboratory-specific background samples.

Sampling Sites and Strategy for Soils and Bandelier Tuff

Soil sampling sites, including mesa tops, canyon bottoms, and colluvial slopes, ranged from Ponderosa pine and fir forests in the wetter, western part of the Laboratory to piñon/juniper woodland in the drier, eastern part (Table 1). The parent materials for the soils included weathered and eroded Bandelier Tuff, alluvium partially derived from Tschicoma dacite in the Sierra de los Valles, wind-blown dust, and El Cajete pumice. Six of the eight sample sites were within the soil mapping area of Nyhan *et al.* (1978), and includes five of their thirteen soil series, although the sample sites were not necessarily typical of soils within each series as described by Nyhan *et al.* (1978).

Whole-rock samples of Bandelier Tuff, collected in Frijoles Canyon within Bandelier National Monument (BNM), represent all stratigraphic units present within the Tshirege Member of the Bandelier Tuff that outcrops in the central and eastern portions of the Laboratory. The background concentrations are probably also representative of tuff found in these units in other parts of the Laboratory. Fresh tuff material collected during this investigation consisted of several kilogram-size samples. Mapping units of the Tshirege Member of the Bandelier Tuff referenced in this report follow the usage of Vaniman and Wohletz (1990) and Goff (1995). Figure 1 shows sampling locations for the Bandelier Tuff within Frijoles Canyon south of the Laboratory boundary in BNM. However, additional, higher stratigraphic units of the Tshirege Member in the western portion of the Laboratory

have not yet been analyzed. Locations for tuff sampling within the Bandelier sections are shown in Figs. 2 and 3. Samples were taken from surface exposures, but material from obvious weathering rinds was excluded. The sampling, to this stage, has been largely limited to the upper (Tshirege) Member of the Bandelier Tuff; only two samples are from the lower (Otowi) Member. Approximately 110 additional samples of the Bandelier Tuff, including the Tshirege and Otowi Members, have been collected by D. Broxton and analytical results of these samples will be provided in a separate report.

Soil samples were collected from eight geographically distinct localities around the perimeter of the Laboratory (shown in Fig. 4). The areas selected for detailed soil characterization are listed below.

Site 1, lower Los Alamos Canyon, north of Tsankawi ruins near State Route 4 (TA-72)

Site 2, EG&G Gully located immediately south of State Route 502 near EG&G (TQA-73)

Site 3, upper Los Alamos Canyon, Los Alamos reservoir road (TA-62)

Site 4, Twomile Mesa within the central portion of TA-69

Site 5, Water Tanks Trench (TA-16), West Jemez Road (State Route 501)

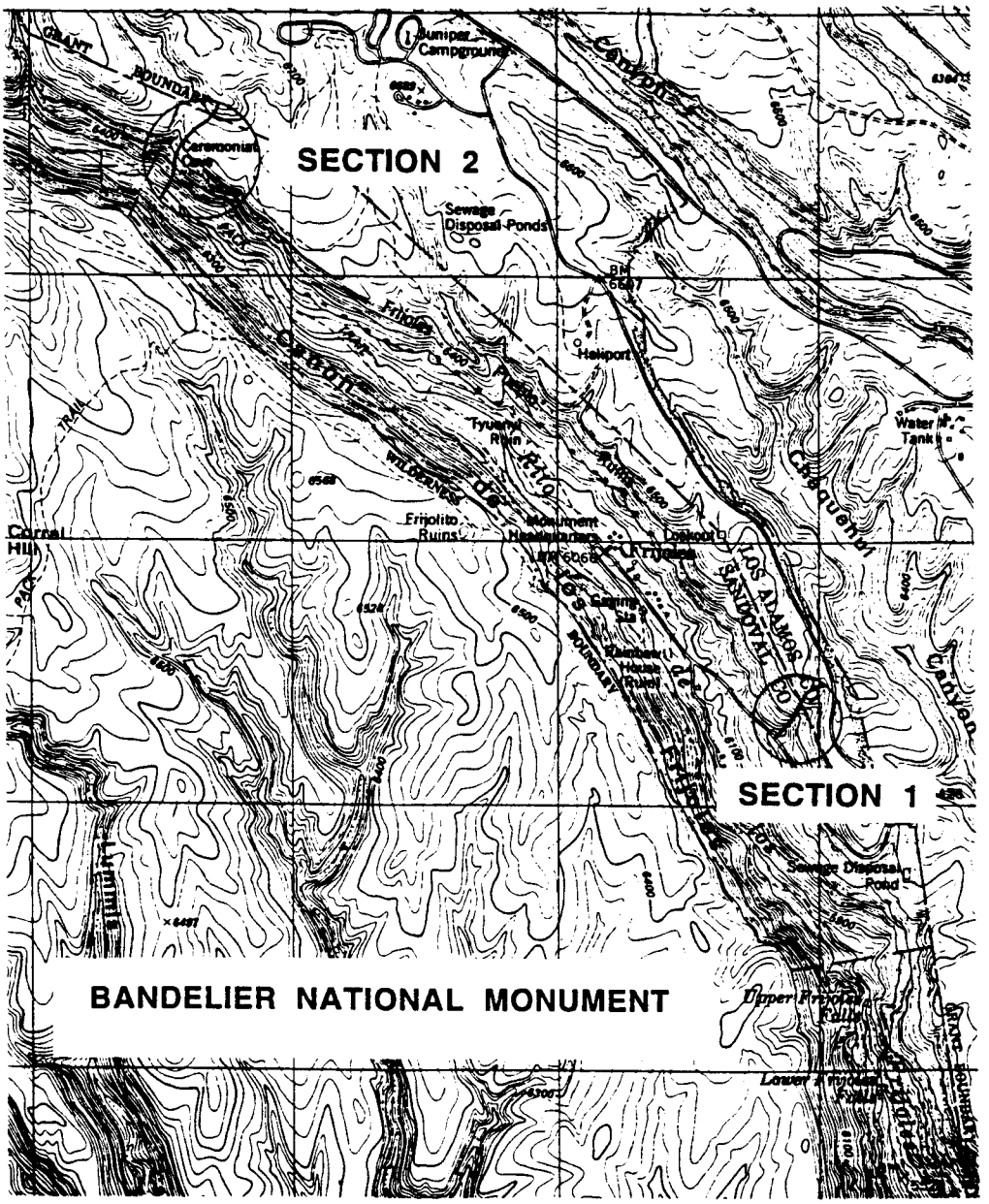
Site 6, Frijoles Mesa (TA-49), State Route 4

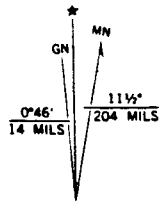
Site 7, Ancho Canyon mesas along State Route 4 (TA-39)

Site 8, fracture fill in a fresh roadcut (TA-46).

Table 1. Summary of Soil Sample Sites

Sample Site	Technical Area	Elevation (ft)	Vegetation	Topographic Setting	Surficial Material
1. Lower Los Alamos Canyon	TA-72	6350	piñon-juniper	canyon bottom	late Holocene fan (last 2800 years)
2. EG&G Gully	TA-73	6950	piñon-juniper	mesa top valley	Holocene valley fill (last 8700 years)
3. Upper Los Alamos Canyon	TA-62	7260	fir	canyon bottom	late Holocene colluvium (last 3300 yr)
4. Twomile Mesa	TA-69	7590	Ponderosa pine	mesa top	old alluvial deposit (post-1.2 Ma)
5. Water Tanks Trench	TA-16	7720	Ponderosa pine	base of scarp	Holocene colluvium
6. Frijoles Mesa	TA-49	6940	Ponderosa pine	mesa top	El Cajete pumice (~60 ka)
7. Ancho Canyon Mesa	TA-39	6570	piñon-juniper	mesa top	pre-El Cajete soil (pre-60 ka)
8. Fracture Fill	TA-46	6980	piñon-juniper	mesa top	pre-El Cajete soil?





UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF MAP DIAGRAM IS APPROXIMATE

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Fig. 1. Location map of Bandelier Tuff samples collected in Frijoles Canyon, Bandelier National Monument, New Mexico.

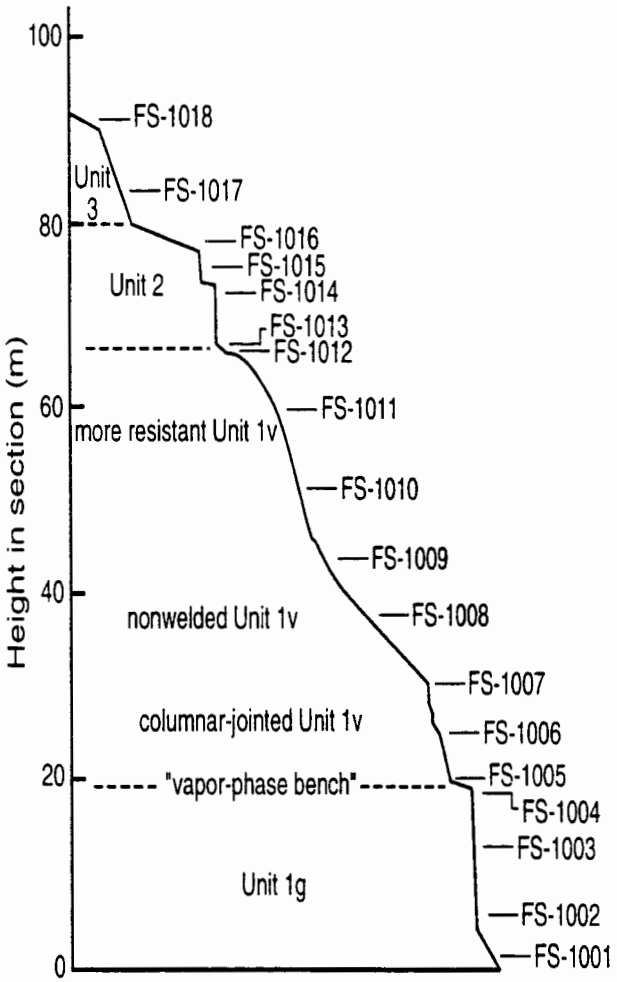


Fig. 2. Location map of Bandelier Tuff samples collected within Section 1, Bandelier National Monument, New Mexico.

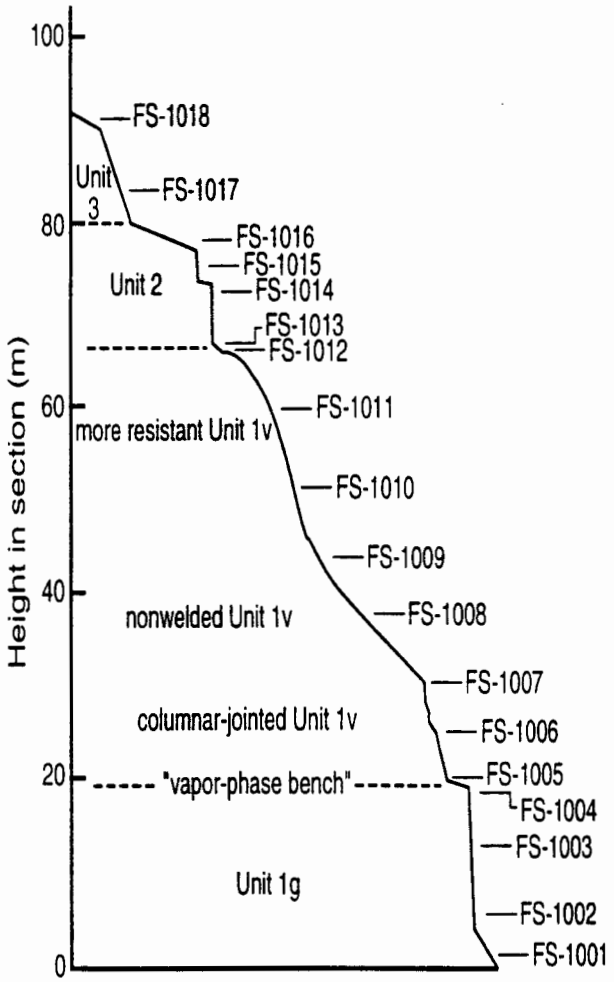


Fig. 3. Location map of Bandelier Tuff samples collected within Section 2, Bandelier National Monument, New Mexico.

These localities allowed partial sampling of the varying degrees of soil development occurring on the Pajarito Plateau. At each location, soil samples were collected at various depths (0 to 300 cm) corresponding to the different soil horizons and weathered Bandelier Tuff. These sites were selected to sample soils influenced by a range of parent materials, topographic settings, local climates, and ages.

The limited number of sample sites precluded coverage of all types of soil present at the Laboratory. In addition, because only one soil profile was sampled from each setting, the natural background variability in soils occurring at similar settings has not yet been evaluated. At some soil profiles, several soil samples consisting of oxidation-reduction zones, calcium carbonate lenses, and solid organic carbon associated with

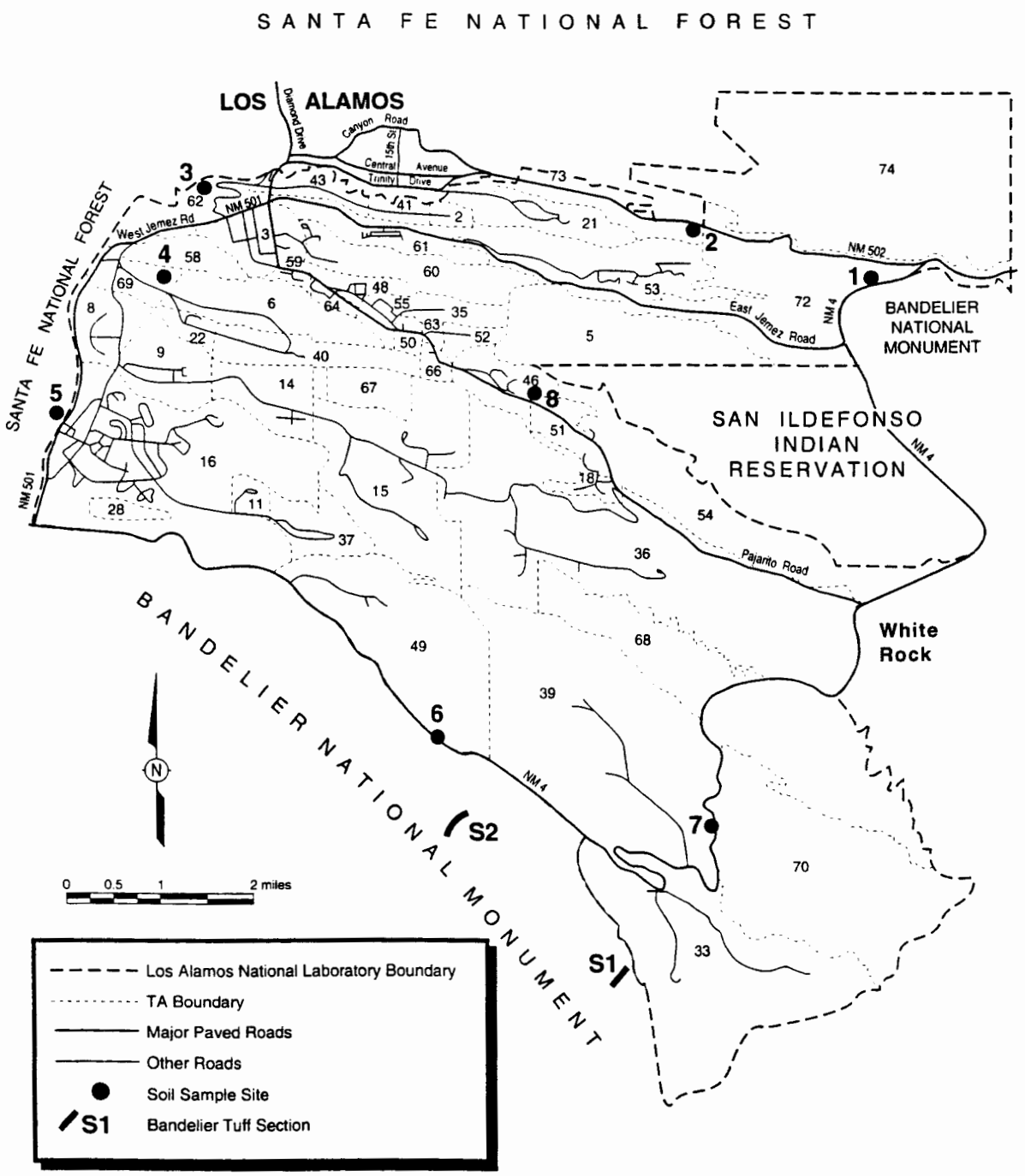


Fig. 4. Map of Los Alamos National Laboratory showing soil and tuff sample sites.

root zones were collected within a given horizon. Additional soil characterization studies will be conducted to determine element concentrations and soil parameters within the same soil horizon(s) at specific soil profiles. For these reasons, this data set is not necessarily representative of the full suite of soils present at the Laboratory and may not include the full range of natural concentrations for all elements.

The different soil horizons were classified and characterized according to their texture, consistency (wet/dry), particle-size distribution, color, clay-mineral content, calcium-carbonate content, organic-carbon content, soil pH, cation exchange capacity (CEC), and bulk density (Watt and McFadden, 1992). Field descriptions comply with guidelines and standard procedures for characterizing soils as described in Birkeland (1984) and Methods of Soils Analysis (American Society of Agronomy, 1986).

Soil samples were passed through a 20 mesh sieve to remove pebbles and twigs. Soil samples were either air-dried or dried in a forced-air-circulation oven at 105°C for 24 hours and then were ground with a corundum mortar and pestle. A standard method for preparing samples of Bandelier Tuff for chemical analyses was used. A large sample of Bandelier Tuff was broken into smaller pieces, which were then placed in a mechanical shaker box (either ceramic or tungsten) and pulverized into a powder. Because of their indurated nature, the Bandelier Tuff samples were more thoroughly ground than the soil samples. All equipment was cleaned and sterilized after each sample preparation.

Sample Digestion and Analytical Techniques

Rock and soil samples were analyzed for a suite of elements using EPA-SW846 methods and other analytical techniques available at the Laboratory. The elements antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), thorium (Th), and uranium (U) are of primary concern to the ER Project because numerous solid waste management units (SWMUs) at the Laboratory potentially contain elevated concentrations of these elements. The SAL for all elements of concern are presented in Table 2. Other elements and compounds of secondary importance to the ER Project include aluminum (Al), bromine (Br), cadmium (Cd), calcium (Ca), cesium (Cs), chlorine (Cl), cobalt (Co), copper (Cu), gallium (Ga), gold (Au),

Table 2. 1995 Screening Action Levels for Selected Elements in Soil

Element	SAL	Element	SAL
Al	78,000	Se	380
Sb	31	Ag	380
Ba	5,300	Sr-90	4.4
Cd	38	Sr	46,000
Cs-137	5.1	Tl	6.4
Cr (III)	80,000	Th-232	0.77
Cr (VI)	30	U-depleted	130 (ppm)
Co	4,600	U-natural	29 (ppm)
Cu	2,800		
Pb	400	U-233	86
Mn	390	U-234	13
Hg	23	U-235	10
Mo	380	U-238	67
Ni	1,500	V	540
		Zn	23,000

[a] SALs are reported in milligram/kilogram (mg/kg, ppm), except for isotopes of cesium, strontium, thorium, and uranium, which reported in pCi/g. Data provided by the US Environmental Protection Agency, Region III (October 27, 1995).

hafnium (Hf), indium (In), iodine (I), iron (Fe), magnesium (Mg), manganese (Mn), potassium (K), rare earth elements (REE), rubidium (Rb), scandium (Sc), selenium (Se), sodium (Na), strontium (Sr), sulfate (SO_4^{2-}), tantalum (Ta), thallium (Tl), titanium (Ti), tungsten (W), vanadium (V), zinc (Zn), and zirconium (Zr). Radioactive isotopes were not analyzed in this investigation because the Laboratory's Group ESH-18 performs annual sampling of soils and sediments for these constituents in both background (equivalent to fallout activities of radionuclides) and facility areas. Additional sampling of background soils for radionuclides may be conducted in the future.

Following sample preparation, Bandelier Tuff and soil samples were submitted to Group EES-1 for x- ray fluorescence (XRF), to Group CST-15 (formerly INC-5) for instrumental and delayed neutron activation analysis (INAA and DNAA), and to Group CST-9 (formerly EM-9) for EPA-SW846 methods including inductively coupled plasma mass spectrometry (ICPMS), inductively coupled plasma emission spectroscopy (ICPES), electrothermal vapor atomic absorption (ETVAA), cold vapor atomic absorption spectroscopy (CVAA), and ion chromatography (IC) analyses. The x-ray fluorescence, INAA, and DNAA techniques provide total element concentration within a solid sample. Appendix A contains INAA and DNAA results for Bandelier Tuff and soils and Appendix B describes EPA SW846 results for soils. Table 3 provides a listing of each analyte and appropriate analytical techniques. The procedures used for these analyses are described in detail in Gautier and Gladney (1986), Gladney *et al.* (1981), Gladney *et al.* (1980), and Garcia (1990).

Table 3. EPA-SW846 and LANL Analytical Techniques Used in LANL Background Soil Investigation

Element	Technique	Element	Technique
Al	ICPES	Mn	ICPES
As	ETVAA	Na	ICPES
Ba	ICPES	Ni	ICPES
Be	ICPES	Pb	ICPES
Ca	ICPES	Sb	ICPES
Cd	ICPES	Se	ETVAA
Cl	IC	Si	XRF
Co	ICPES	SO_4	IC
Cr	ICPES	Ta	ICPMS
Cu	ICPES	Th	ICPMS
Fe	ICPES	Ti	XRF
Hg	CVAA	Tl	ICPMS
K	ICPES	U	ICPMS
Mg	ICPES	V	ICPES

ICPES—inductively coupled plasma emission spectroscopy
ICPMS—inductively coupled plasma mass spectrometry
IC—ion chromatography
CVAA—cold vapor atomic absorption spectroscopy
ETVAA—electrothermal vapor atomic absorption spectroscopy
XRF—x ray fluorescence

Quality assurance was provided by concurrent analysis of different National Institute of Standards and Technology (NIST), US Environmental Protection Agency (US EPA), and US Geological Survey (USGS) reference materials described by Gladney *et al.* (1981) and Garcia (1990).

Soil samples were analyzed for total element concentrations following complete digestion using INAA and DNAA. Aliquots or splits from the same samples were also digested using concentrated HNO_3, HCl, and H_2O_2 (EPA Method 3050A) and were analyzed for the same elements using EPA SW846 methods, including ICPES, ICPMS, IC, and ETVAA. The lowest detection limits for specific analytes and species using ICPES, ICPMS, IC, and ETVAA were

0.08 (Be), 0.12 (Ta), 12 (sulfate), and 0.3 (As) ppm, respectively. Precision values for Be, Ta, sulfate, and As were ±10%, ±10%, ±10%, and ±20%, respectively. Precision values for other elements typically were ±10%. Quality-control samples, including duplicates and spiked samples, were analyzed at frequencies specified by the US EPA.

Soil samples submitted for ICPMS, ICPES, ETVAA, CVAA, and IC analyses were either completely digested using HF (Be, Cd, and Pb) or partly digested (extracted) using nitric acid (HNO_3). The sample digestion/dissolution step controls the leachability and, ultimately, the concentration of each analyte reported by the analytical laboratory. Many trace and major elements, including Al, Ba, Na, K, U, and Th, are structurally incorporated within primary mineral lattices and amorphous solids (primarily glass). Subsequently, HF digestion of a sample results in higher concentrations for elements than partial digestion using HNO_3 would provide. Other trace elements, including As and Be, are mainly concentrated on surfaces of soil particles that consist of clay minerals and ferric oxyhydroxide-ferric hydroxide (termed iron oxides) through adsorption processes. Under these circumstances, HF and HNO_3 digestions yield similar analyte concentrations. Therefore, the type of digestion of environmental samples strongly influences analytical results. Consistent and appropriate digestion procedures should be used to allow comparability of data.

Element leaching from soils is evaluated by comparing analytical results from HNO_3 digestion to those obtained from HF digestion. Large differences in concentrations of the total element and HNO_3-digested samples suggest that minimal redistribution of elements from primary silicates to secondary surface coatings has occurred and most of the element is chemically bound or tied up within the primary silicate minerals. Small differences in element concentrations between HNO_3-digested samples and total-element analyses suggest that elements have been largely mobilized and concentrated on surfaces and/or coprecipitated with acid-soluble phases.

Statistical Analysis of Background-Element Concentrations in Soils

Comparisons between site and background data are needed as part of the Resource Conservation and Recovery Act (RCRA) corrective-action process developed by the EPA. This report contains UTL values for different elements (metals and nonmetals). In this initial data set, soil horizons are grouped together for calculating an UTL value for each element. Additional statistical analyses, including calculation of a horizon-specific UTL for each element, will be performed as more background-element data are collected for soils. The ER Project follows the general guidance provided in *"Statistical Analysis of Ground-Water Monitoring Data"* (EPA, 1989). Details of this approach are presented in the background comparison guidance document for the ER Project (Ryti, 1995). Two types of statistical comparisons to background data are presented in this guidance document. The first method is based on calculation of the UTL for background data. The UTL is equal to the mean plus the standard deviation multiplied by k-factors (one-sided normal tolerance factors), using the 99th percentile at 95% confi-

dence. The UTL is a "hot measurement" test—meaning that site data that are greater than the UTL-calculated threshold value are "in excess" of normal maximum background concentration for a particular element. Values of UTL for naturally occurring metals and nonmetals in soil samples, which encompassed A, B, and C horizons at the Laboratory, are presented in Table 4. These values are also extrapolated for radioisotopes of K, Th, and U by assuming natural abundance of each isotope.

Table 4. List of Upper Tolerance Limits (UTLs) for LANL Soil Background Data

Analyte	SAL (mg/kg)	Mean[a] (mg/kg)	Standard Deviation (mg/kg)	UTL 99%,0.95 (mg/kg)	N	N > DL
Aluminum (LT)	78,000	19000	13800	123000	47	47
Antimony	31	2.45	0.36	2.5 (MAX)	46	2
Arsenic		4.4	2.5	11.6	46	46
Barium (LT)	5,300	161	129	1140	47	47
Beryllium		1.15	0.75	3.31	47	47
Cadmium	38	0.39	0.54	2.7 (MAX)	47	5
Calcium (LT)		5790	12500	54400	47	47
Chromium (Total)[b]		11.7	7.8	34.2	47	47
Cobalt	4,600	15.2	7.6	51.1	47	47
Copper	2,800	5.3	3.6	15.7	47	45
Iron		14500	7320	35600	47	47
Lead	400	15.0	8.3	39.0	47	44
Magnesium (LT)		2920	2150	16100	47	47
Manganese	390	343	238	1030	47	47
Mercury	23	0.05	0.01	0.1 (MAX)	48	4
Molybdenum	380	NA	NA	NA	NA	NA
Nickel	1,500	9.7	5.9	26.7	47	45
Potassium		2420	1304	6180	47	47
Selenium	380	0.43	0.41	1.7 (MAX)	46	23
Silver	380	NA	NA	NA	NA	NA
Sodium		577	453	1880	47	47
Strontium	46,000	NA	NA	NA	NA	NA
Thallium	6.4	0.27	0.24	0.9 (MAX)	45	21
Uranium, natural	29	0.86	0.43	2.09	46	46
Vanadium	540	25	14	66	47	47
Zinc	23,000	41	21	101	47	47
40-Potassium[c]		21.6	5.07	36.1	50	50
232-Thorium[c]	0.77	1.71	0.34	2.68	50	50
234-Uranium[c]	13	1.21	0.29	2.03	50	50
235-Uranium[c]	10	0.052	0.012	0.088	50	50
238-Uranium[c]	67	1.14	0.27	1.90	50	50

[a]Concentration values <DL (detection limit) were replaced by 1/2 of the DL.
[b]SAL for Chromium-III is 80,000 mg/kg and for Chromium-VI is 30 mg/kg.
[c]Data are converted from elemental concentrations reported in this LANL background report (units are pCi/g).
LT - UTL is based on log transformed data.
NA - data not available for LANL background.
MAX - Maximum value is reported, rather than the UTL.