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to: Hans Oldewage, MS- 0854 (7575)

from: Rick Haaker, MS-0854 (7575)

subject: Radon flux testing at the Mixed Waste and the adjacent Classified Waste Landfills,
Technical Area III, SNL/NM

During the time period September 30, 1997 to October 1, 1997, radon flux testing was completed on the Mixed Waste and Classified Waste Landfills, Technical Area III, SNL/NM. The placement of the four inch diameter activated charcoal radon canisters was done by Hans Oldewage and Mike Schaub. Sample locations are indicated on the attached map (Attachment 1).

The activity of radon daughters on the canisters was determined by Thermo NUtech using gamma spectroscopy. The gamma spectroscopy data from Thermo NUtech was entered into a Microsoft Access database and verified. A summary of the gamma spectroscopy data is provided as Attachment 2. Detailed radon flux calculation results are provided in Attachment 3. A summary of radon flux results is provided below as Table 1.

Attachment 4 provides results for ambient radon concentrations and results for field blanks measured at the same time radon flux samples were being collected.

Attachment 5 contains the radon data reports produced by Thermo NUtech.

Findings and Conclusions

No significant difference between the landfill and the background measurements in terms of median, mean, or standard deviation was observed. The probability distribution of either data set appears to be approximately normal as evidenced by the nearness of the χ -square test values (for two degrees of freedom) to the ideal result of 1.39 that would be expected for normally distributed data sets.

The radon flux measurement technique employed for this study was capable of detecting radon fluxes in the range of 1-2% of the the 20 pCi/ m²/s limit listed in draft 10 CFR 834. The highest result is only about 5% of the 20 pCi/m²/s limit.

Both the landfill and background radon flux dataset averages are slightly below the background radon flux value of 0.45 pCi/m²/s for soil listed in NCRP 97, *Measurement of Radon and Radon Daughters in Air*. Based on these results, no need for follow-up radon flux measurements at the Mixed Waste Landfill or the adjacent Classified Waste Landfill is evident.

Table 1. Radon flux results in summary form

Factor	Landfill dataset	Background dataset
Number of measurements	71	18
Number of detects	42	15
Percentage of detects	59%	83%
Completeness	100%	95%
Minimum flux, pCi/m ² /sec	0.026	-0.193
Maximum flux, pCi/m ² /sec	1.021	0.664
Median flux, pCi/m ² /sec	0.33	0.35
Mean, pCi/m ² /sec	0.35	0.36
Standard Deviation (1 σ), pCi/m ² /sec	0.20	0.19
χ -square (5 bins, 2 dof)	1.89	1.44
Minimum LLD, pCi/m ² /sec ^{1,2}	0.22	0.22
Maximum LLD, pCi/m ² /sec	0.44	0.43

RH/7575/rh

Enclosures: as stated

Copy to:

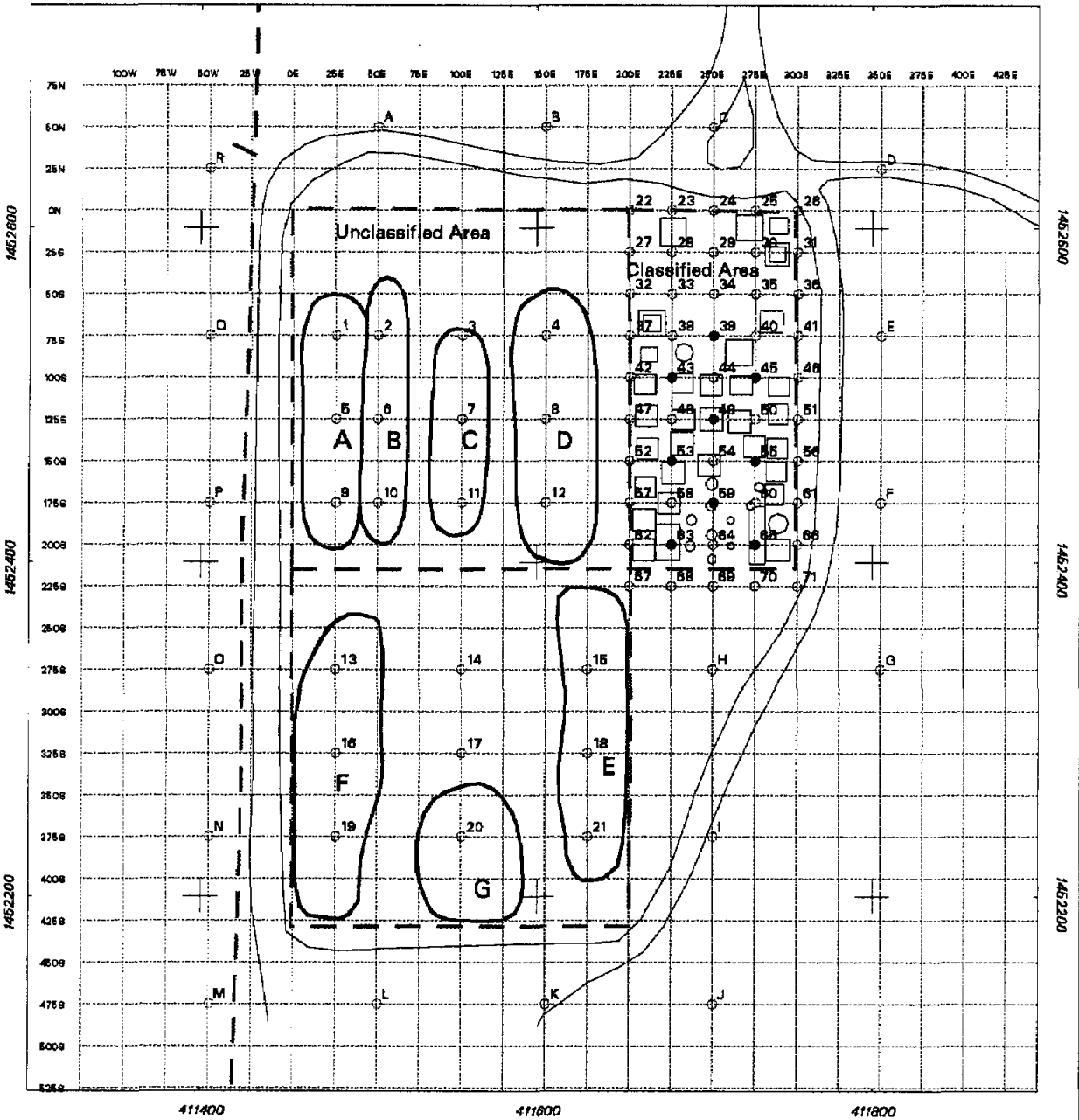
MS1148 6134 Gerry Peace (w/o attachment #5)
MS0854 7575 Todd Culp (attachment #1 only)
MS0854 7575 Hue-Su Hwang (attachment #1 only)
MS0854 7575 10CFR834 Project File
MS0651 15101 ES&H Records Center (Environmental Radiation Protection Program Documents)

¹ Lloyd A Currie, Limits for Qualitative Detection and Quantitative Determination, Application to Radiochemistry, *Analytical Chemistry*, Vol 40, No. 3, p 586 (1968).

² Based on 3 minute count time for samples and background.

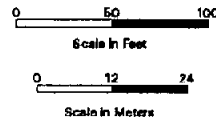
Attachment 1:

Sample Locations



Legend

- Canister in down position only
- One canister in up position & one canister in down position
- Pits & Trenches
- Fence
- Road



1in = 100ft 1:1200

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Mixed Waste Landfill

Attachment 2:

Summary of Gamma Spectroscopy Data

Loc ID	Exposure Time(h)	Decay Time(h)	Gross Count	Counting Efficiency	Backgd CPM
1	24.483	54.867	452	0.2683	106.5
2	24.483	27.983	451	0.2615	107.9
3	24.450	50.550	466	0.2683	106.5
4	24.467	122.917	369	0.2687	103.8
5	24.467	53.383	539	0.2683	106.5
6	24.450	123.467	422	0.2687	103.8
7	24.483	122.700	417	0.2687	103.8
8	24.483	48.817	369	0.2683	106.5
9	24.483	50.100	411	0.2683	106.5
10	24.467	28.017	491	0.2615	107.9
11	24.433	48.317	465	0.2683	106.5
12	24.433	55.767	339	0.2683	106.5
13	24.267	122.917	432	0.2687	103.8
14	24.250	45.767	352	0.2683	106.5
15	24.250	122.683	410	0.2687	103.8
16	24.233	51.767	432	0.2683	106.5
17	24.233	53.050	370	0.2683	106.5
18	24.233	50.933	352	0.2683	106.5
19	24.233	47.183	421	0.2683	106.5
20	24.233	123.483	377	0.2683	106.5
21	24.233	55.467	393	0.2683	106.5
22	24.500	47.983	453	0.2683	106.5
23	24.500	53.967	465	0.2683	106.5
24	24.517	52.983	377	0.2683	106.5
25	24.500	28.700	398	0.2615	107.9
26	24.500	50.950	406	0.2683	106.5
27	24.483	28.733	450	0.2615	107.9
28	24.783	46.817	432	0.2683	106.5
29	24.750	55.400	328	0.2683	106.5
30	24.733	54.583	385	0.2683	106.5
31	24.383	122.683	428	0.2687	103.8
32	24.467	48.100	515	0.2683	106.5
33	24.733	55.300	378	0.2683	106.5
34	24.717	55.633	379	0.2683	106.5
35	24.717	54.917	382	0.2683	106.5
36	24.383	51.767	402	0.2683	106.5
37	24.467	50.583	447	0.2683	106.5
38	24.717	48.483	418	0.2683	106.5
39	24.717	56.267	381	0.2683	106.5
40	24.700	55.650	358	0.2683	106.5
41	24.400	55.633	449	0.2683	106.5

Loc ID	Exposure Time(h)	Decay Time(h)	Gross Count	Counting Efficiency	Backgd CPM
42	24.467	47.600	522	0.2683	106.5
43	24.683	48.017	383	0.2683	106.5
44	24.667	123.600	449	0.2687	103.8
45	24.667	54.633	367	0.2683	106.5
46	24.383	46.883	433	0.2683	106.5
47	24.483	27.950	543	0.2615	107.9
48	24.633	28.717	488	0.2615	107.9
49	24.633	54.317	357	0.2683	106.5
50	24.600	54.683	391	0.2683	106.5
51	24.350	53.117	517	0.2683	106.5
52	24.467	52.583	432	0.2683	106.5
53	24.617	52.417	478	0.2683	106.5
54	24.600	28.800	425	0.2615	107.9
55	24.600	51.883	391	0.2683	106.5
56	24.350	53.733	513	0.2683	106.5
57	24.433	47.800	524	0.2683	106.5
58	24.583	45.617	393	0.2683	106.5
59	24.550	29.233	433	0.2615	107.9
60	24.533	28.933	337	0.2615	107.9
61	24.350	55.117	494	0.2683	106.5
62	24.433	45.367	483	0.2683	106.5
63	24.533	28.467	350	0.2615	107.9
64	24.533	50.783	658	0.2683	106.5
65	24.517	47.767	346	0.2683	106.5
66	24.317	55.183	519	0.2683	106.5
67	24.317	49.633	505	0.2683	106.5
68	24.300	53.500	475	0.2683	106.5
69	24.317	27.450	499	0.2615	107.9
70	24.317	122.933	377	0.2687	103.8
71	24.317	53.250	370	0.2683	106.5

Loc ID	Exposure Time(h)	Decay Time(h)	Gross Count	Counting Efficiency	Backgd CPM
A	24.433	50.567	374	0.2683	106.5
B	24.450	55.667	398	0.2683	106.5
C	24.450	51.433	415	0.2683	106.5
D	24.417	53.233	432	0.2683	106.5
E	24.350	54.133	492	0.2683	106.5
F	24.350	55.033	496	0.2683	106.5
G	24.283	51.900	465	0.2683	106.5
H	24.267	52.233	404	0.2683	106.5
I	24.283	54.250	460	0.2683	106.5
J	24.217	50.383	467	0.2683	106.5
K	24.217	54.433	258	0.2683	106.5
L	24.217	54.483	428	0.2683	106.5
M	24.183	45.117	533	0.2683	106.5
N	24.183	50.100	433	0.2683	106.5
O	24.183	54.017	465	0.2683	106.5
P	24.183	122.383	438	0.2687	103.8
Q	24.167	28.133	431	0.2615	107.9
R	24.167	45.150	422	0.2683	106.5

LocID	StartT&D	StopT&D	CountT&D	GrossCount	CountingEfficiency	BackgroundCPM
1	10:20-0	10:49-1	17:41-3	452	0.2683	106.5
2	10:21-0	10:50-1	14:49-2	451	0.2615	107.9
3	10:23-0	10:50-1	13:23-3	466	0.2683	106.5
4	10:23-0	10:51-1	13:46-6	369	0.2687	103.8
5	10:24-0	10:52-1	16:15-3	539	0.2683	106.5
6	10:25-0	10:52-1	14:20-6	422	0.2687	103.8
7	10:25-0	10:54-1	13:36-6	417	0.2687	103.8
8	10:26-0	10:55-1	11:44-3	369	0.2683	106.5
9	10:26-0	10:55-1	13:1-3	411	0.2683	106.5
10	10:27-0	10:55-1	14:56-2	491	0.2615	107.9
11	10:29-0	10:55-1	11:14-3	465	0.2683	106.5
12	10:30-0	10:56-1	18:42-3	339	0.2683	106.5
13	11:5-0	11:21-1	14:16-6	432	0.2687	103.8
14	11:6-0	11:21-1	9:7-3	352	0.2683	106.5
15	11:7-0	11:22-1	14:3-6	410	0.2687	103.8
16	11:8-0	11:22-1	15:8-3	432	0.2683	106.5
17	11:9-0	11:23-1	16:26-3	370	0.2683	106.5
18	11:10-0	11:24-1	14:20-3	352	0.2683	106.5
19	11:10-0	11:24-1	10:35-3	421	0.2683	106.5
20	11:11-0	11:25-1	14:54-6	377	0.2683	106.5
21	11:11-0	11:25-1	18:53-3	393	0.2683	106.5
22	10:15-0	10:45-1	10:44-3	453	0.2683	106.5
23	10:15-0	10:45-1	16:43-3	465	0.2683	106.5
24	10:15-0	10:46-1	15:45-3	377	0.2683	106.5
25	10:17-0	10:47-1	15:29-2	398	0.2615	107.9
26	10:17-0	10:47-1	13:44-3	406	0.2683	106.5
27	10:33-0	11:2-1	15:46-2	450	0.2615	107.9
28	9:38-0	10:25-1	9:14-3	432	0.2683	106.5
29	9:40-0	10:25-1	17:49-3	328	0.2683	106.5
30	9:42-0	10:26-1	17:1-3	385	0.2683	106.5
31	10:46-0	11:9-1	13:50-6	428	0.2687	103.8
32	10:35-0	11:3-1	11:9-3	515	0.2683	106.5
33	9:43-0	10:27-1	17:45-3	378	0.2683	106.5
34	9:44-0	10:27-1	18:5-3	379	0.2683	106.5
35	9:45-0	10:28-1	17:23-3	382	0.2683	106.5
36	10:47-0	11:10-1	14:56-3	402	0.2683	106.5
37	10:36-0	11:4-1	13:39-3	447	0.2683	106.5
38	9:46-0	10:29-1	10:58-3	418	0.2683	106.5
39	9:46-0	10:29-1	18:45-3	381	0.2683	106.5
40	9:48-0	10:30-1	18:9-3	358	0.2683	106.5
41	10:47-0	11:11-1	18:49-3	449	0.2683	106.5
42	10:36-0	11:4-1	10:40-3	522	0.2683	106.5
43	9:49-0	10:30-1	10:31-3	383	0.2683	106.5
44	9:51-0	10:31-1	14:7-6	449	0.2687	103.8
45	9:52-0	10:32-1	17:10-3	367	0.2683	106.5
46	10:49-0	11:12-1	10:5-3	433	0.2683	106.5
47	10:36-0	11:5-1	15:2-2	543	0.2615	107.9
48	9:55-0	10:33-1	15:16-2	488	0.2615	107.9

LocID	StartT&D	StopT&D	CountT&D	GrossCount	CountingEfficiency	BackgroundCPM
49	9:56--0	10:34--1	16:53--3	357	0.2683	106.5
50	9:58--0	10:34--1	17:15--3	391	0.2683	106.5
51	10:51--0	11:12--1	16:19--3	517	0.2683	106.5
52	10:37--0	11:5--1	15:40--3	432	0.2683	106.5
53	9:58--0	10:35--1	15:0--3	478	0.2683	106.5
54	9:59--0	10:35--1	15:23--2	425	0.2615	107.9
55	10:0--0	10:36--1	14:29--3	391	0.2683	106.5
56	10:52--0	11:13--1	16:57--3	513	0.2683	106.5
57	10:40--0	11:6--1	10:54--3	524	0.2683	106.5
58	10:2--0	10:37--1	8:14--3	393	0.2683	106.5
59	10:4--0	10:37--1	15:51--2	433	0.2615	107.9
60	10:6--0	10:38--1	15:34--2	337	0.2615	107.9
61	10:53--0	11:14--1	18:21--3	494	0.2683	106.5
62	10:40--0	11:6--1	8:28--3	483	0.2683	106.5
63	10:7--0	10:39--1	15:7--2	350	0.2615	107.9
64	10:8--0	10:40--1	13:27--3	658	0.2683	106.5
65	10:10--0	10:41--1	10:27--3	346	0.2683	106.5
66	10:55--0	11:14--1	18:25--3	519	0.2683	106.5
67	10:59--0	11:18--1	12:56--3	505	0.2683	106.5
68	10:59--0	11:17--1	16:47--3	475	0.2683	106.5
69	10:58--0	11:17--1	14:44--2	499	0.2615	107.9
70	10:57--0	11:16--1	14:12--6	377	0.2687	103.8
71	10:56--0	11:15--1	16:30--3	370	0.2683	106.5
U39	9:47--0	10:29--1	12:48--3	365	0.2683	106.5
U43	9:50--0	10:30--1	13:5--3	344	0.2683	106.5
U45	9:52--0	10:32--1	14:24--6	366	0.2687	103.8
U49	9:57--0	10:34--1	17:27--3	300	0.2683	106.5
U53	9:59--0	10:35--1	15:49--3	312	0.2683	106.5
U55	10:1--0	10:36--1	9:22--3	343	0.2683	106.5
U59	10:5--0	10:37--1	17:6--3	352	0.2683	106.5
U63	10:7--0	10:40--1	15:36--3	310	0.2683	106.5
U65	10:10--0	10:41--1	12:52--3	329	0.2683	106.5
Zontrol	9:30--0	11:30--1	13:58--6	365	0.2687	103.8
zontrol	9:30--0	11:30--1	11:47--3	302	0.2683	106.5
A	10:31--0	10:57--1	13:31--3	374	0.2683	106.5
B	10:31--0	10:58--1	18:38--3	398	0.2683	106.5
C	10:32--0	10:59--1	14:25--3	415	0.2683	106.5
D	10:44--0	11:9--1	16:23--3	432	0.2683	106.5
E	10:50--0	11:11--1	17:19--3	492	0.2683	106.5
F	10:54--0	11:15--1	18:17--3	496	0.2683	106.5
G	11:1--0	11:18--1	15:12--3	465	0.2683	106.5
H	11:2--0	11:18--1	15:32--3	404	0.2683	106.5
I	11:3--0	11:20--1	17:35--3	460	0.2683	106.5
J	11:13--0	11:26--1	13:49--3	467	0.2683	106.5
K	11:14--0	11:27--1	17:53--3	258	0.2683	106.5
L	11:15--0	11:28--1	17:57--3	428	0.2683	106.5
M	11:17--0	11:28--1	8:35--3	533	0.2683	106.5
N	11:18--0	11:29--1	13:35--3	433	0.2683	106.5

LocID	StartT&D	StopT&D	CountT&D	GrossCount	CountingEfficiency	BackgroundCPM
O	11:19 -- 0	11:30 -- 1	17:31 -- 3	465	0.2683	106.5
P	11:20 -- 0	11:31 -- 1	13:54 -- 6	438	0.2687	103.8
Q	11:22 -- 0	11:32 -- 1	15:40 -- 2	431	0.2615	107.9
R	11:23 -- 0	11:33 -- 1	8:42 -- 3	422	0.2683	106.5

Attachment 3:

Radon Flux Results

Radon Flux Results. Flux values presented in italics exceed the lower limit of detection as defined by Currie.

Loc ID	Flux, pCi/m ² sec	2 * std dev of flux, pCi/m ² sec	LLD flux, pCi/m ² sec
1	<i>4.130E-01</i>	1.7E-01	2.6E-01
2	<i>3.3E-01</i>	1.5E-01	2.2E-01
3	<i>4.4E-01</i>	1.7E-01	2.5E-01
4	<i>3.0E-01</i>	2.7E-01	4.3E-01
5	<i>6.8E-01</i>	1.8E-01	2.6E-01
6	<i>5.8E-01</i>	2.8E-01	4.3E-01
7	<i>5.5E-01</i>	2.8E-01	4.3E-01
8	1.5E-01	1.6E-01	2.5E-01
9	<i>2.8E-01</i>	1.6E-01	2.5E-01
10	<i>4.4E-01</i>	1.5E-01	2.2E-01
11	<i>4.3E-01</i>	1.7E-01	2.5E-01
12	6.1E-02	1.6E-01	2.6E-01
13	<i>6.3E-01</i>	2.9E-01	4.3E-01
14	9.5E-02	1.5E-01	2.4E-01
15	<i>5.2E-01</i>	2.8E-01	4.3E-01
16	<i>3.5E-01</i>	1.7E-01	2.6E-01
17	1.6E-01	1.6E-01	2.6E-01
18	9.9E-02	1.6E-01	2.5E-01
19	<i>3.0E-01</i>	1.6E-01	2.5E-01
20	<i>3.0E-01</i>	2.8E-01	4.4E-01
21	2.3E-01	1.7E-01	2.6E-01
22	<i>3.9E-01</i>	1.6E-01	2.5E-01
23	<i>4.5E-01</i>	1.7E-01	2.6E-01
24	1.8E-01	1.6E-01	2.6E-01
25	1.9E-01	1.4E-01	2.2E-01
26	<i>2.6E-01</i>	1.6E-01	2.5E-01
27	<i>3.3E-01</i>	1.5E-01	2.2E-01
28	<i>3.3E-01</i>	1.6E-01	2.4E-01
29	2.6E-02	1.6E-01	2.6E-01
30	2.0E-01	1.6E-01	2.6E-01
31	<i>6.1E-01</i>	2.8E-01	4.3E-01
32	<i>5.8E-01</i>	1.7E-01	2.5E-01
33	1.8E-01	1.6E-01	2.6E-01
34	1.8E-01	1.6E-01	2.6E-01
35	1.9E-01	1.6E-01	2.6E-01
36	2.5E-01	1.6E-01	2.5E-01
37	<i>3.8E-01</i>	1.7E-01	2.5E-01
38	<i>2.9E-01</i>	1.6E-01	2.4E-01
39	1.9E-01	1.7E-01	2.6E-01

Radon Flux Results (Continued).

Loc ID	Flux, pCi/m ² sec	2 * std dev of flux, pCi/m ² sec	LLD flux, pCi/m ² sec
40	1.2E-01	1.6E-01	2.6E-01
41	4.1E-01	1.7E-01	2.6E-01
42	6.0E-01	1.7E-01	2.5E-01
43	1.9E-01	1.6E-01	2.4E-01
44	7.2E-01	2.9E-01	4.3E-01
45	1.5E-01	1.6E-01	2.6E-01
46	3.3E-01	1.6E-01	2.4E-01
47	5.7E-01	1.5E-01	2.2E-01
48	4.3E-01	1.5E-01	2.2E-01
49	1.2E-01	1.6E-01	2.6E-01
50	2.2E-01	1.7E-01	2.6E-01
51	6.1E-01	1.8E-01	2.6E-01
52	3.4E-01	1.7E-01	2.5E-01
53	4.8E-01	1.7E-01	2.5E-01
54	2.6E-01	1.4E-01	2.2E-01
55	2.2E-01	1.6E-01	2.5E-01
56	6.0E-01	1.8E-01	2.6E-01
57	6.1E-01	1.7E-01	2.5E-01
58	2.1E-01	1.5E-01	2.4E-01
59	2.9E-01	1.4E-01	2.2E-01
60	3.5E-02	1.3E-01	2.2E-01
61	5.5E-01	1.8E-01	2.6E-01
62	4.8E-01	1.6E-01	2.4E-01
63	6.9E-02	1.4E-01	2.2E-01
64	1.0E+00	1.9E-01	2.5E-01
65	7.8E-02	1.5E-01	2.5E-01
66	6.3E-01	1.8E-01	2.6E-01
67	5.6E-01	1.7E-01	2.5E-01
68	4.8E-01	1.8E-01	2.6E-01
69	4.6E-01	1.5E-01	2.2E-01
70	3.4E-01	2.7E-01	4.3E-01
71	1.6E-01	1.6E-01	2.6E-01

Radon Flux Results (Continued).

Loc ID	Flux, pCi/m ² sec	2 * std dev of flux, pCi/m ² sec	LLD flux, pCi/m ² sec
A	1.6E-01	1.6E-01	2.5E-01
B	2.5E-01	1.7E-01	2.6E-01
C	<i>2.9E-01</i>	1.6E-01	2.5E-01
D	<i>3.5E-01</i>	1.7E-01	2.6E-01
E	<i>5.4E-01</i>	1.8E-01	2.6E-01
F	<i>5.5E-01</i>	1.8E-01	2.6E-01
G	<i>4.5E-01</i>	1.7E-01	2.6E-01
H	<i>2.6E-01</i>	1.7E-01	2.6E-01
I	<i>4.4E-01</i>	1.7E-01	2.6E-01
J	<i>4.5E-01</i>	1.7E-01	2.5E-01
K	-1.9E-01	1.5E-01	2.6E-01
L	<i>3.4E-01</i>	1.7E-01	2.6E-01
M	<i>6.3E-01</i>	1.7E-01	2.4E-01
N	<i>3.5E-01</i>	1.7E-01	2.5E-01
O	<i>4.6E-01</i>	1.8E-01	2.6E-01
P	<i>6.6E-01</i>	2.9E-01	4.3E-01
Q	<i>2.8E-01</i>	1.5E-01	2.2E-01
R	<i>3.0E-01</i>	1.6E-01	2.4E-01

Attachment 5:

Radon Reports Provided by Thermo Nutech