APPENDIX B-20

EVALUATION OF POTENTIAL HAZARDS OF DEPLETED URANIUM

EVALUATION OF POTENTIAL HAZARDS OF DEPLETED URANIUM

Process	Maximum Amount of Source Material Involved in Each Process at Any One Time
Melting	500 lbs.
Casting	500 lbs.
Heat Treatment	200 lbs.
Forging	250 lbs.
Extruding	250 lbs.
Swaging	150 lbs.
Machining	500 lbs.

1. Hazards.

Uranium presents a two fold hazard: first from its chemical toxicity; and second, from the ionizing alpha, beta, and gamma radiation emitted in the process of radioactive decay. The ionizing radiations are hazardous when small amounts of uranium are taken into the body or when relatively large amounts are present in close proximity to the body. However, the chemical properties of uranium present a hazard only after it is absorbed into the blood streams. Fortunately, uranium is absorbed to a very limited extent through unbroken skin or the gastronintestinal tract, and its specific activity is quite low in comparison with most other radioactive elements. Harmful exposures to either hazard can be prevented by careful handling techniques and common sense.

a. External. The isotopes of uranium found in normal or depleted mixtures emit alpha particles accompanied by very low energy gamma radiation in the process of radioactive decay. The alpha radiation presents no hazard unless the uranium gets into the body. The gamma radiation is of such low energy that it constitutes no hazard except to parts of the body in contact with large quantities of uranium for extended periods of time. After chemical refining the beta particle emissions of UX_1 and UX_2 ($_{90}Th^{234}$ and $_{91}Pa^{234}$), the first two daughters of $_{92}U^{238}$, make up nearly all the penetrating radiation associated with either normal or depleted uranium.

The radiation dose rate at the surface of a bare uranium metal slab is 263 mrem/hr. The 2.32 Mev $\beta-$ from $_{91}Pa^{234}$ contributes 240 mrem/hr and the 0.1 or 0.2 Mev $\beta-$ from $_{90}Th^{234}$ adds another 20 mrem/hr. The gamma rays are all quite soft and all only 2.7 mrem/hr. The melting and casting of uranium result in the migration of the UX_1 and UX_2 daughters to the surface of the casting. The concentration of these beta emitters on the interior surfaces of molds and crucibles, on the exterior surfaces of castings, and in the slag results in dose rates as high as 2 R/hr. These surface deposits are removed quickly and easily by washing resulting in limited exposure to personnel.

b. Internal. Uranium can gain access to the body by way of injection, ingestion, or inhalation. Absorption through unbroken skin is negligible; absorption via injection is likely to occur only in such cases as contamination of open wounds; and absorption via ingestion is approximately 1% of intake. Inhalation of uranium compounds is the significant mode of entry. Once in the body uranium can cause damage by radiation and by chemical toxicity.

c. Chemical Toxicity. Once uranium enters the blood stream in a chemically active form, its toxicity is comparable to that of arsenic, lead, or mercury. Fortunately, the dusts most likely to be encountered in industrial processing of uranium are relatively insoluble and so inert physiologically that they are considered as radiological hazards rather than toxic chemicals. These are deposited primarily in the respiratory system from which they are mobilized slowly. The more soluble compounds of uranium are quickly taken into the blood stream via lungs or contaminated wounds and may result in significant deposits of UO_2 in the kidney. There some of the uranium combines with the protein of cell walls, poisoning the cells and interfering with the vital functions of waste elimination and maintenance of electrolyte balance. The uranium does not remain fixed in the kidney, but is eliminated at the rate of about half every two weeks. Moderately severe damage to the kidney as a result of acute exposure is reparable, and a return toward normal kidney function may occur even during continued exposure.

d. Radiation Hazards. The principal radiation hazard from internal deposits of uranium is the intense ionization in tissue produced by the alpha particles emitted during radioactive decay. The more than 4 Mev energy of the alpha particles is absorbed in the first 0.1 mm of tissue, resulting in localized cellular damage. On the otherhand, gamma rays and beta particles dissipate their energies in relatively larger volumes of tissue and produce comparatively little damage.

Many industrial uranium dusts are relatively insoluble and are deposited primarily in the respiratory system. A fixed deposit of uranium in the lung is eliminated at the rate of about half every 120 days.

2. Hazard Control and Evaluation.

a. External. Uranium does not constitute a serious external radiation hazard. The time honored methods for controlling exposure to external sources of radiation are distance, time, and shielding. The intensity of gamma radiation from a point source rapidly decreases with distance away from the source. Beta radiation intensity is decreased even more rapidly with distance. In the case of uranium there is relatively little radiation exposure at a few feet from the material. The length of time a person may remain in any given area or at any particular job can be limited on the basis of instrument evaluations of the radiation conditions. It is not necessary to use massive shielding or special manipulating devices to decrease exposures in working with normal or depleted uranium. The 2.32 Mev betas from these materials will be stopped completely by about 0.5 in. of water, even less plastic (Lucite), or less than 0.25 in. of glass. A horse-hide leather glove can decrease the radiation dose to the hands as much as 80%.

Internal. Since the principal health hazard in dealing with uranium compounds is that of inhalation, the basic methods of control are enclosure and ventilation. Depleted uranium processing areas are provided with adequate general ventilation and special or local ventilation appropriate for the kind of operations performed. Commercially available respiratory protective devices are used for protection against short term high concentrations. Educational programs and administrative procedures that place emphasis on proper handling techniques are used to supplement mechanical controls. Usually the sampling of uranium particulates in the atmosphere, the standard method of evaluating inhalation hazards, is accomplished by drawing air through a filter at a measured rate. The amount of uranium, UX_1 and UX_2 collected on the filter from a known volume of air is determined by measurement of the alpha and beta radioactivity. The procedure for determining airborne activity is as follows:

(1) Air samples are collected by filtering air through a filter at a known rate of flow and for a predetermined time. Routine spot samples are collected by running the air sampler for a 20 minute period.

(2) Counting technique utilizes a 2" planchet for holding the sample to be counted. The filter paper is placed in the planchet and counted for 30 minutes.

(3) The total count obtained is divided by the counting time to determine the counting rate in counts per minute.

(4) The background count rate of the detector is subtracted from the counts per minute to obtain the corrected counts per minutes.

(5) The corrected counts per minute is divided by the efficiency of the detector to determine the disintegrations per minute (dpm).

(6) The airborne activity is then computed as follows:

$$\text{airborne activity} = \frac{\text{dpm}}{(2.22 \times 10^6 \text{dpm/uc})\ (\text{volume of air sampled})}$$

(7) The calculated activity is then compared with limits specified in AEC Reg 10 CFR Part 20.

c. Melting and Casting. Uranium is melted and cast under either a vacuum or some inert gas. This contains all radiation and contamination during the melt. During melting and casting, the radioactive daughter products segregate from the uranium. They are found mostly in the crucible residues and on surfaces of rough castings. This segregation is so pronounced that very real radiation hazards will be found.

(1) Melting. The vacuum melting operation is unique in that the daughter products of uranium are brought to the surface of the melt and are found in the ingot, the surface of the melt, and the lining of the furnace. This radioactive material must be removed. After pouring, the top surface of the ingot is cropped and the sides are machined under local exhaust ventilation. Patching of the furnace lining periodically results in another health physics problem involving external radiation and airborne particulate matter. Shielding the personnel who perform this job is difficult because of the freedom of movement required for the operation. Gloves and lead aprons are unsatisfactory. One solution is to use a movable aluminum shield which is placed inside the furnace. Aluminum was chosen since higher atomic number elements produce Bremstahlung radiation when exposed to beta radiation. The beta radiation associated with the daughter products has an effective range of 1100 centimeters. This is more than enough to penetrate the epidermes layer of skin and may potentially cause beta burns. However, the aluminum shield is only open in that quadrant in which the worker is either cleaning or patching the lining. Even with the shield, the worker must be limited as to the amount of time spent in the furnace. Respirators are required during the patching operation.

(2) Casting. When graphite crucibles are used for casting uranium, they must be machined after each heat. Considering that the crucible is now contaminated with radioactive daughter products, the ventilation problem during machining operation requires careful consideration. Airborne particulate matter may be far above the MPC. The ventilating system used for this operation utilizes a hood enclosure of a combination of sheet metal and lucite plastic in conjunction with the exhaust system.

d. Heat Treatment. No special measures are required for heat treatment operations.

e. Hot Working.

(1) Forging. Health physics precautions are not stringent in press forging because there is very little airborne contamination.

(2) Extruding. No special health physics precautions are considered necessary with the exception of conducting proper clean up after extrusion was completed. The heating of the billets is conducted in properly vented salt baths.

f. Cold Working (Swaging). No special measures are required for normal swaging operations.

g. Machining. To maintain the level of airborne particulate uranium below the MPC, all machining operations are provided with local exhaust ventilation. The degree or extent of ventilation varies with the nature, amount, and method of release of the contaminant. All machining is performed under coolant. Since uranium is pyrophoric, a generous supply of coolant is used to flood both the tool and work piece to prevent fires and to reduce airborne contamination. All machines are thoroughly cleaned at least once a month.

Respiratory Protection.

(1) Respirators are required for all operations in which airborne radioactivity concentrations might exceed 10% of the maximum permissible concentrations established in Title 10 Part 20. In addition, they will be worn when directed by the Health Physicist.

(2) The type respirator to be used is the American Optical R-6057 Sure Guard Respirator with the Super Micro-Toxisol R-57 Filter. See Figure I for manufacturer's instructions regarding fitting, cleaning and maintenance of these respirators.

(3) The supervisors are responsible for insuring that personnel are instructed in the proper use of respirators and wear them as required. Work will be programed in such a manner that respirators will not be worn for periods longer than 45 minutes at any one time nor more than 5 hours in any one work week.

(4) Experience has shown that the average concentrations encountered in areas occupied by employees fall within three to five times the MPC established in 10 CFR 20.

EVALUATION OF POTENTIAL HAZARDS OF THORIA

1. Maximum Amount of Source Material Involved in Each Process at Any One Time - Two (2) grams

2. Hazards

The thoria is used as a crucible material because of its high temperature characteristics. Thoria presents no hazards in the quantities used for this application. The thoria crucible is set inside a tantulum crucible and heated to a temperature of 2000 - 2300° C in a high vacuum system. The thoria crucible remains intact during the melting cycle. The crucibles are usually used once and disposed of as radioactive waste.

3. Hazard Control and Evaluation

Same as for depleted uranium.

APPENDIX C
ARGONNE NATIONAL LABORATORY DATA

DOE/EV-0005/38

ANL-OHS/HP-83-108

FORMERLY UTILIZED MED/AEC SITES REMEDIAL ACTION PROGRAM

RADIOLOGICAL SURVEY OF THE FORMER WATERTOWN ARSENAL PROPERTY

GSA SITE

WATERTOWN, MASSACHUSETTS

Watertown, MA

OCCUPATIONAL HEALTH AND SAFETY DIVISION
Health Physics Section
ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

Operated by THE UNIVERSITY OF CHICAGO
for the U. S. DEPARTMENT OF ENERGY
under Contract W-31-109-Eng-38

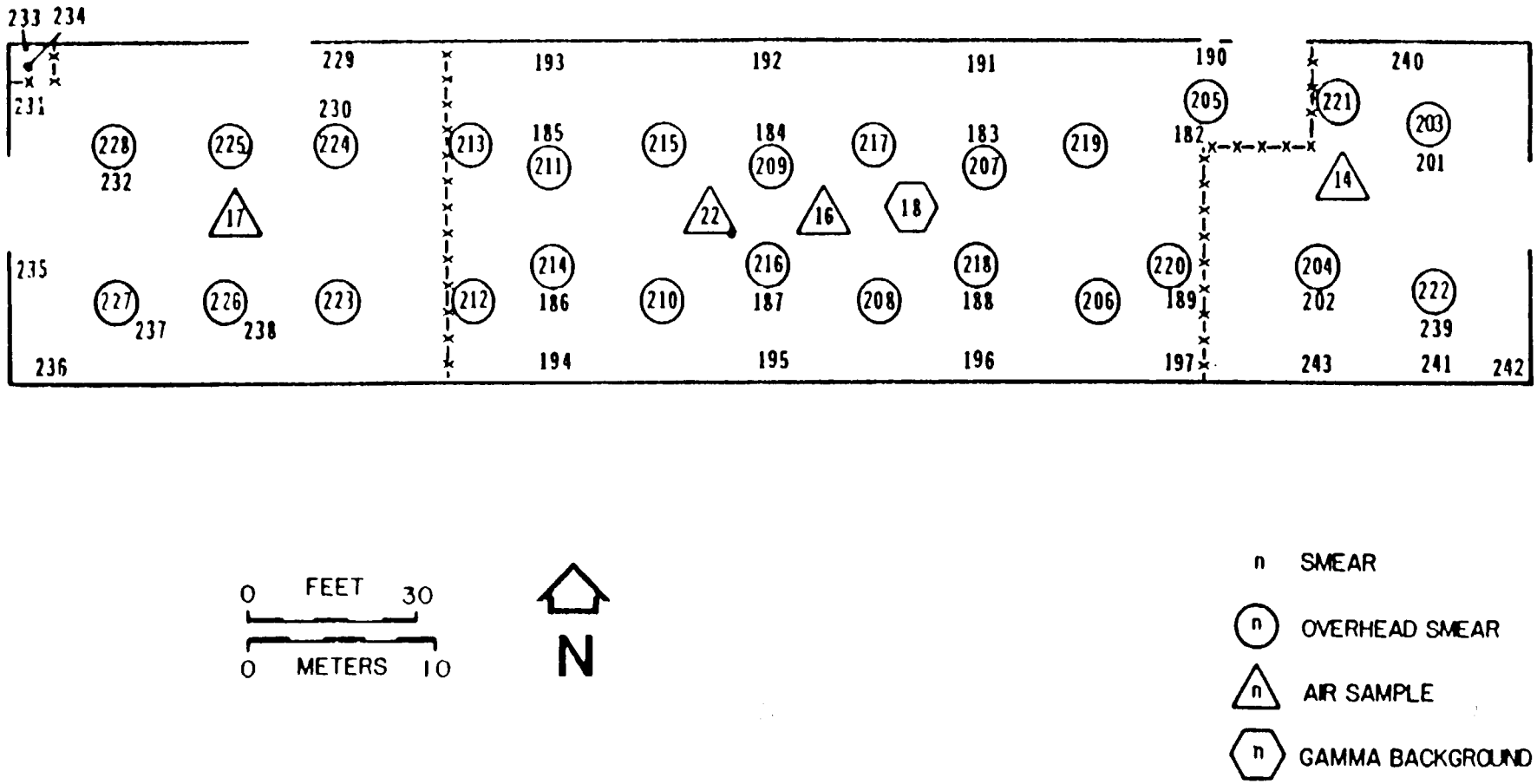

Fig. 9. Building 234.
ANL-HP Dwg. No. 82-13

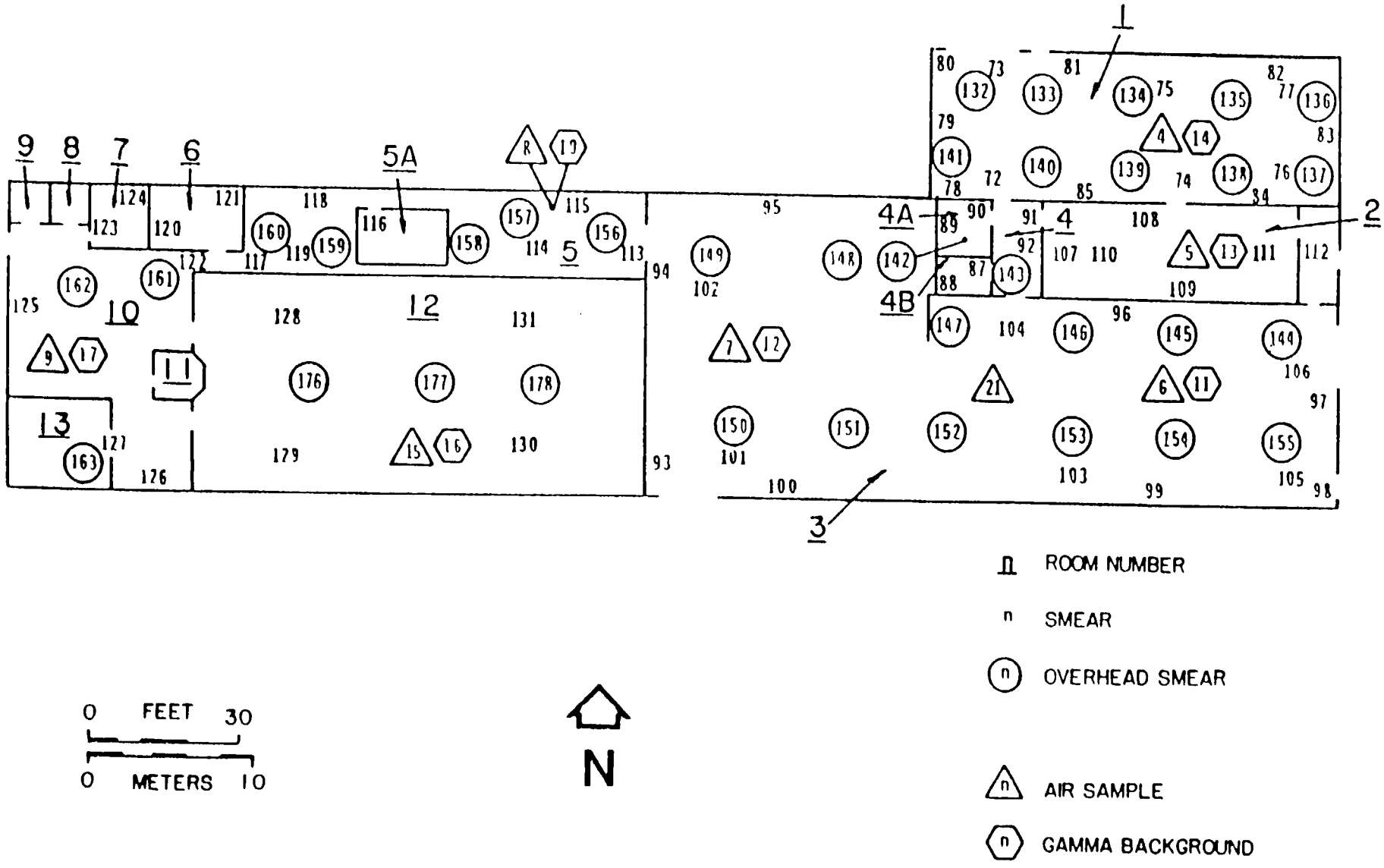

Fig. 10. Building 235.
ANL-HP Dwg. No. 82-12.

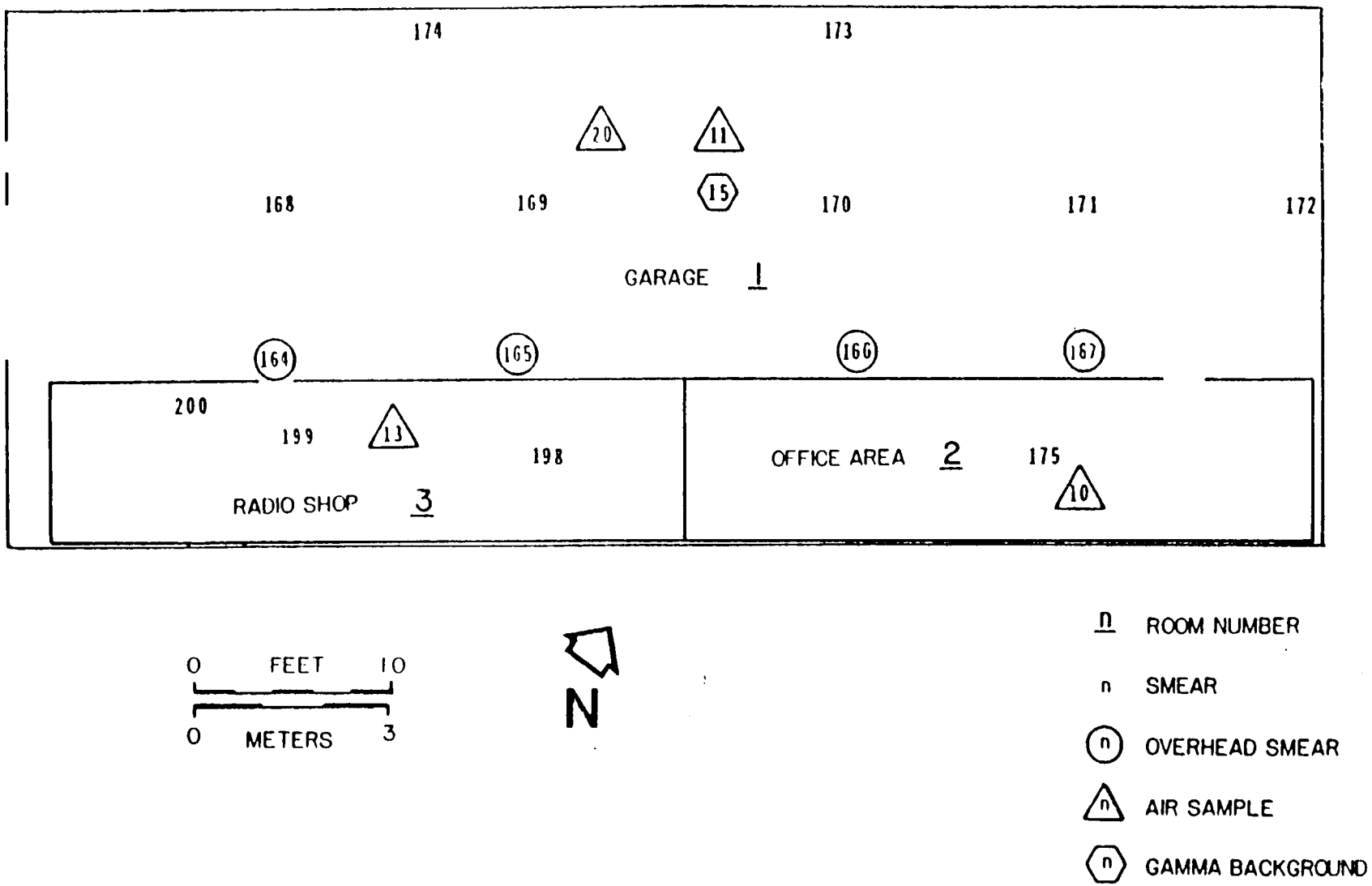

Fig. 11. Building 236.
ANL-HP Dwg. No. 82-14

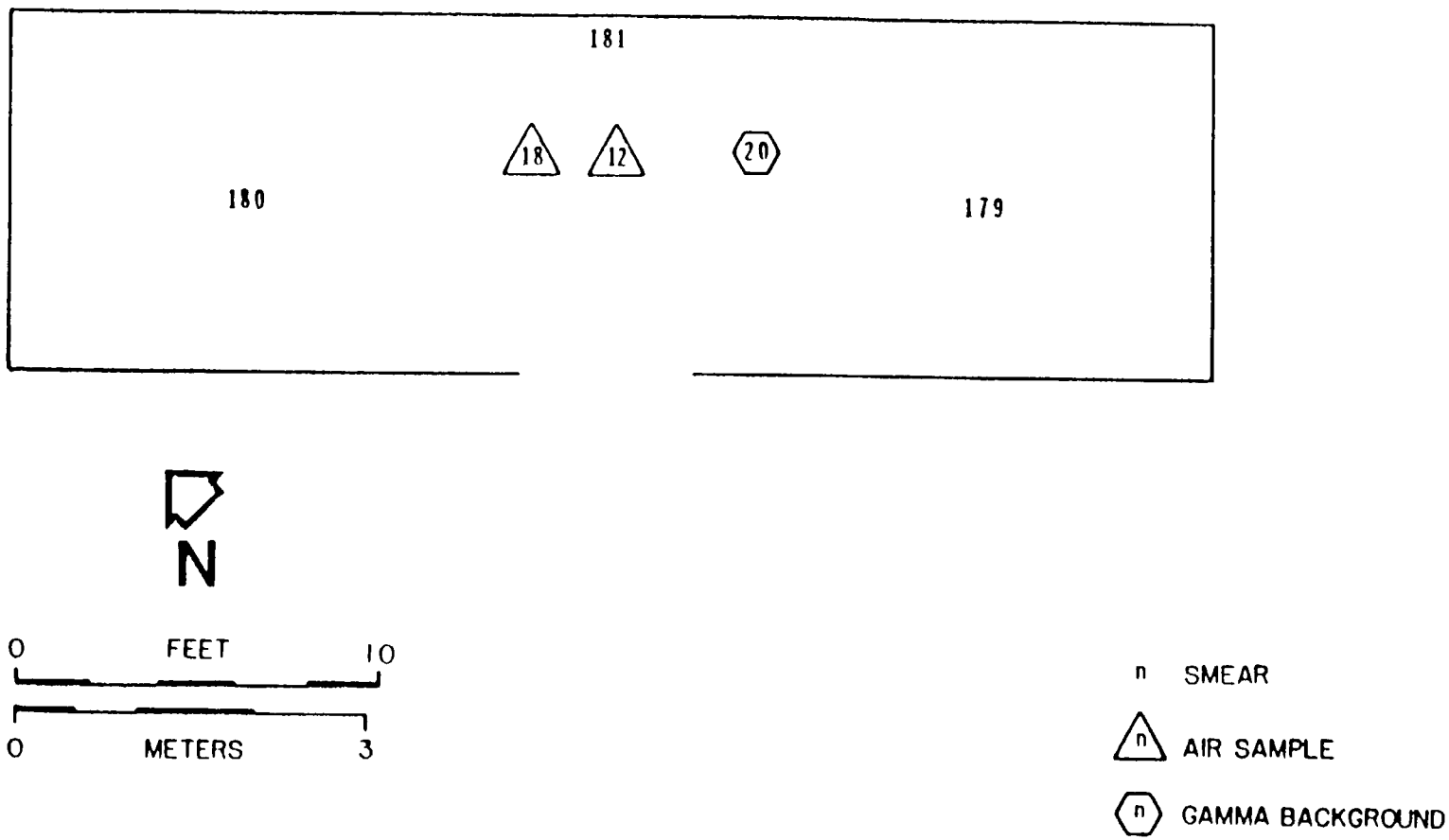

Fig. 12. Building 237.
ANL-HP Dwg. No. 82-15

TABLE 2

AMBIENT RADIATION LEVELS

Location[a] Area	No.	Grid	Duration of Measurement (h)	Radiation Level RSS-111 (μR/h)	Corresponding PRM-7 Measurement (μR/h)
INTERIOR					
Bldg. 234					
	18		65.5	8.9	7
Bldg. 235					
	11		4.0	8.8	7
	12		3.0	8.3	7
	13		4.0	9.0	8
	14		3.0	10.2	8
	16		3.4	8.9	8
	17		4.1	9.4	8
	19		6.0	11.2	8
Bldg. 236					
	15		6.2	8.6	8
Bldg. 237					
	20		4.1	8.8	8
EXTERIOR					
I	1	M-2	3.3	17.7	34
	2	M-2	2.5	11.6	13
II	3	M-3	4.5	9.8	7
	4	K-3	2.1	11.7	10
	7	H-2	6.2	7.5	5
III	5	H-3	3.0	10.7	9
	6	F-4	3.8	12.6	11
	10	E-4	2.3	10.0	10
IV	9	I-1	2.5	10.2	10
V	8	O-2	1.8	9.6	10
	21	Q-2	2.9	14.6	15
	22	Q-1	3.1	12.4	12

[a]Locations are shown on maps in Figures 5 and 9 through 12.

TABLE 3

RADON-CONCENTRATION DETERMINATIONS[a]

Air Sample Number	Location	WL[b]	Radon (^{222}Rn), pCi/ℓ
4	Building 235, Room 1	0.0074	0.74
5	Building 235, Room 2	0.0065	0.65
6	Building 235, Room 3 East	0.0102	1.02
7	Building 235, Room 3 West	0.0085	0.85
8	Building 235, Room 5	0.0038	0.38
9	Building 235, Room 10	0.0058	0.58
10	Building 236, Office	0.0046	0.46
11	Building 236, Garage	0.0015	0.15
12	Building 237, Shed	0.0004	0.04
13	Building 236, Radio Shop	0.0006	0.06
14	Building 234, East	0.0010	0.10
15	Building 235, Pistol Range	0.0096	0.96
16	Building 234, Center	0.0027	0.27
17	Building 234, West	0.0054	0.54

TABLE 3
(cont'd.)

Air Sample Number	Location	WL[b]
18[c]	Building 237, Shed	No actinon
20[c]	Building 236, Garage	No actinon
21[c]	Building 235, Room 3 Center	No actinon
22[c]	Building 234, Center	No actinon

[a]Locations are shown on maps in Figures 9 through 12.

[b]A Working Level (WL) is defined in 10 CFR 712 as any combination of short-lived radon-daughter products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy. The numerical value of the WL is derived from the alpha energy released by the total decay through RaC' of the short-lived radon-daughter products, RaA, RaB, and RaC at radioactive equilibrium with 100 pCi of ^{222}Rn per liter of air.

[c]Actinon determination.

TABLE 1

DATA SHEET OF AREA SURVEYS

Room or Area No.	Percent of Area Accessible for Survey: Floor	Percent of Area Accessible for Survey: Wall	Air Sample (WL)	PAC 4G-3 Direct Readings[a] (dis/min-100 cm²): Beta	PAC 4G-3 Direct Readings[a] (dis/min-100 cm²): Alpha	End Window GM (mR/h) Contact	PRM-7 (μR/h) 1 meter	PRM-5-3 w/PG-2 (cts/min)	Smear Results (dis/min-100 cm²)	Comments
AREA I:										
34				1000	BKGD	0.8	40	45000		< 100 cm²
35				2500	BKGD	0.03	40	50000		< 100 cm²
36				400	BKGD	0.03	30	20000		< 100 cm²
37				500	BKGD	0.07	10	10000		< 100 cm²
38				500	BKGD	0.04	20	3000		< 100 cm²
39[b]				15000	250	0.2	20	10000		< 100 cm²
40[b]				50000	400	5.0	20	35000		< 100 cm²
41				2000	BKGD	0.1	20	5000		< 100 cm²
42				500	BKGD	0.1	20	5000		< 100 cm²
43				3000	BKGD	0.15	20	15000		< 100 cm²
44				3000	BKGD	0.5	20	15000		< 100 cm²
45				2000	100	0.6	20	10000		< 100 cm²
46				500	BKGD	0.05	20	5000		< 100 cm²
AREA II:[c]										
47-53, N-54[b], 60, N-3				4500	BKGD	0.14	30	30000		< 700 cm²
				45000	250	7.0	30	50000		< 200 cm²

TABLE 1

DATA SHEET OF AREA SURVEYS

Room or Area No.	Percent of Area Accessible for Survey		Air Sample (WL)	PAC 4G-3 Direct Readings[a] (dis/min-100 cm²)		End Window GM (mR/h)	PRM-7 (μR/h)	PRM-5-3 w/PG-2 (cts/min)	Smear Results (dis/min-100 cm²)	Comments
	Floor	Wall		Beta	Alpha	Contact	1 meter			
55-57, N-3				4000	BKGD	0.7	30	30000		1100 cm²
59, 61-63, N-3				25000	300	0.7	30	50000		47000 cm²
58, M-3				400	BKGD	0.03	30	2000		900 cm²
71, L-2				300	BKGD	0.03	30	2000		3700 cm²
64-66, L-3				1000	BKGD	0.08	30	10000		< 300 cm²
67-70, K-3				10000	BKGD	0.02	30	50000		< 400 cm²
AREA III										
General				1000	BKGD	BKGD	10	2000		
AREA IV										
General				500	BKGD	BKGD	20	3000		
AREA V										
72, 73, 77, N-1				250	BKGD	0.03	20	10000		< 300 cm²

TABLE 1

DATA SHEET OF AREA SURVEYS

Room or Area No.	Percent of Area Accessible for Survey Floor	Wall	Air Sample (WL)	PAC 4G-3 Direct Readings[a] (dis/min-100 cm²) Beta	Alpha	End Window GM (mR/h) Contact	PRM-7 (μR/h) 1 meter	PRM-5-3 w/PG-2 (cts/min)	Smear Results (dis/min-100 cm²)	Comments
AREA V (cont'd.)										
74-76, N-2				15000	BKGD	3.0	20	25000		< 300 cm²
79-82, O-1				250	BKGD	0.04	20	3000		< 300 cm²
78, O-2				250	BKGD	0.04	20	2000		< 100 cm²
83, P-1				250	BKGD	0.03	20	2000		< 100 cm²
89, P-2				250	BKGD	0.03	20	3000		< 100 cm²
84, Q-1				250	BKGD	0.03	20	2000		< 100 cm²
85-88, Q-2				400	BKGD	0.03	20	7000		< 300 cm²

[a]All instrument readings include backgrounds (PAC-4GB, 250 cpm, PRM-5-3, 400 cpm, GM, 0.03 mR, PRM-7, 10 μR).

[b]Metal chips were found at these locations.

[c]Grid locations are shown in Figure 6.

TABLE 2

AMBIENT RADIATION LEVELS

Location[a] Area	No.	Grid	Duration of Measurement (h)	Radiation Level RSS-111 (μR/h)	Corresponding PRM-7 Measurement (μR/h)
INTERIOR					
Bldg. 234					
	18		65.5	8.9	7
Bldg. 235					
	11		4.0	8.8	7
	12		3.0	8.3	7
	13		4.0	9.0	8
	14		3.0	10.2	8
	16		3.4	8.9	8
	17		4.1	9.4	8
	19		6.0	11.2	8
Bldg. 236					
	15		6.2	8.6	8
Bldg. 237					
	20		4.1	8.8	8
EXTERIOR					
I	1	M-2	3.3	17.7	34
	2	M-2	2.5	11.6	13
II	3	M-3	4.5	9.8	7
	4	K-3	2.1	11.7	10
	7	H-2	6.2	7.5	5
III	5	H-3	3.0	10.7	9
	6	F-4	3.8	12.6	11
	10	E-4	2.3	10.0	10
IV	9	I-1	2.5	10.2	10
V	8	O-2	1.8	9.6	10
	21	Q-2	2.9	14.6	15
	22	Q-1	3.1	12.4	12

[a]Locations are shown on maps in Figures 5 and 9 through 12.

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9	Building 235, Room 10	0.0058	0.58
10	Building 236, Office	0.0046	0.46
11	Building 236, Garage	0.0015	0.15
12	Building 237, Shed	0.0004	0.04
13	Building 236, Radio Shop	0.0006	0.06
14	Building 234, East	0.0010	0.10
15	Building 235, Pistol Range	0.0096	0.96
16	Building 234, Center	0.0027	0.27
17	Building 234, West	0.0054	0.54

TABLE 3
(cont'd.)

Air Sample Number	Location	WL[b]
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21[c]	Building 235, Room 3 Center	No actinon
22[c]	Building 234, Center	No actinon

[a]Locations are shown on maps in Figures 9 through 12.

[b]A Working Level (WL) is defined in 10 CFR 712 as any combination of short-lived radon-daughter products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy. The numerical value of the WL is derived from the alpha energy released by the total decay through RaC' of the short-lived radon-daughter products, RaA, RaB, and RaC at radioactive equilibrium with 100 pCi of ^{222}Rn per liter of air.

[c]Actinon determination.

TABLE 4

GAMMA SPECTRAL AND URANIUM FLUOROMETRIC ANALYSES OF SOIL SAMPLES

Sample No.	Gamma Spectra, pCi/g±σ ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric[a] µg/g ± 10%	Uranium Fluorometric[a] pCi/g ± 10%
			SOIL CORINGS		
1-S47-A	1.54 ± 0.11	1.03 ± 0.07	1.36 ± 0.09	824.0 ± 82.4	334.0 ± 33.4[b]
B	1.96 ± 0.14	1.04 ± 0.07	1.21 ± 0.09	2227.0 ± 222.7	902.0 ± 90.2[b]
C	0.53 ± 0.05	0.86 ± 0.07	1.52 ± 0.11	736.0 ± 73.6	298.0 ± 29.8[b]
D	<0.03	0.35 ± 0.07	0.62 ± 0.06	46.2 ± 4.6	18.7 ± 1.9[b]
1-S48-A	1.10 ± 0.08	1.03 ± 0.07	1.60 ± 0.11	595.0 ± 59.5	241.0 ± 24.1[b]
B	0.79 ± 0.07	1.33 ± 0.09	1.89 ± 0.13	484.0 ± 48.4	196.0 ± 19.6[b]
C	0.24 ± 0.04	1.24 ± 0.09	1.81 ± 0.13	100.0 ± 10.0	40.5 ± 4.1[b]
D	0.08 ± 0.03	0.98 ± 0.07	1.53 ± 0.11	47.0 ± 4.7	19.0 ± 1.9[b]
1-S49-A	1.08 ± 0.11	1.48 ± 0.15	1.21 ± 0.12	372.0 ± 37.2	151.0 ± 15.1[b]
B	0.90 ± 0.09	1.62 ± 0.16	0.92 ± 0.09	412.0 ± 41.2	167.0 ± 16.7[b]
C	0.51 ± 0.05	1.05 ± 0.11	1.30 ± 0.13	218.0 ± 21.8	88.3 ± 8.8[b]
D	0.29 ± 0.03	1.08 ± 0.11	1.04 ± 0.10	84.3 ± 8.4	34.1 ± 3.4[b]
1-S50-A	1.03 ± 0.10	0.67 ± 0.07	0.83 ± 0.08	403.0 ± 40.3	163.0 ± 16.3[b]
B	0.67 ± 0.07	0.83 ± 0.08	0.97 ± 0.10	761.0 ± 76.1	308.0 ± 30.8[b]
C	0.53 ± 0.05	0.73 ± 0.07	1.03 ± 0.10	859.0 ± 85.9	348.0 ± 34.8[b]
D	0.63 ± 0.06	0.87 ± 0.09	1.40 ± 0.14	637.0 ± 63.7	258.0 ± 25.8[b]
1-S51-A	0.33 ± 0.03	0.70 ± 0.07	1.08 ± 0.11	2.4 ± 0.2	1.6 ± 0.2
B	0.70 ± 0.07	0.78 ± 0.08	1.00 ± 0.10	3.3 ± 0.3	2.3 ± 0.2
C	1.01 ± 0.10	1.01 ± 0.10	1.18 ± 0.12	3.8 ± 0.4	2.6 ± 0.2
D	0.35 ± 0.04	0.84 ± 0.08	0.97 ± 0.10	2.2 ± 0.2	1.5 ± 0.2
1-S52-A	1.12 ± 0.11	1.25 ± 0.13	1.85 ± 0.19	6.4 ± 0.6	4.4 ± 0.4
B	0.81 ± 0.08	1.36 ± 0.14	1.84 ± 0.18	5.2 ± 0.5	3.6 ± 0.4
C	0.58 ± 0.06	1.22 ± 0.12	1.76 ± 0.18	4.4 ± 0.4	3.0 ± 0.3
D	0.04 ± 0.02	1.01 ± 0.10	0.90 ± 0.09	1.9 ± 0.2	1.3 ± 0.2

Table 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[a] ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric µg/g ± 10%	pCi/g ± 10%
1-S53-A	1.91 ± 0.19	0.76 ± 0.08	1.35 ± 0.14	7.0 ± 0.7	3.9 ± 0.4[c]
B	2.11 ± 0.21	1.20 ± 0.12	2.02 ± 0.20	5.7 ± 0.6	3.9 ± 0.4
C	1.42 ± 0.14	1.15 ± 0.12	1.60 ± 0.16	3.7 ± 0.4	2.5 ± 0.3
D	0.20 ± 0.04	1.26 ± 0.13	1.61 ± 0.16	2.4 ± 0.2	1.6 ± 0.2
1-S54-A	2.49 ± 0.25	0.67 ± 0.07	1.10 ± 0.11	10.6 ± 1.1	5.2 ± 0.5[c]
B	2.68 ± 0.27	0.96 ± 0.10	1.20 ± 0.12	6.6 ± 0.7	3.6 ± 0.4[c]
C	0.59 ± 0.06	0.94 ± 0.09	1.12 ± 0.11	2.9 ± 0.3	2.0 ± 0.2
D	0.12 ± 0.04	1.44 ± 0.14	1.15 ± 0.12	2.1 ± 0.2	1.4 ± 0.2
1-S55-A	1.55 ± 0.16	1.10 ± 0.11	0.49 ± 0.05	1.8 ± 0.2	1.2 ± 0.2
B	1.74 ± 0.17	1.20 ± 0.12	0.88 ± 0.09	2.6 ± 0.3	1.8 ± 0.2
C	1.62 ± 0.16	1.00 ± 0.10	1.31 ± 0.13	4.4 ± 0.4	3.0 ± 0.3
D	0.36 ± 0.04	1.51 ± 0.15	1.31 ± 0.13	2.2 ± 0.2	1.5 ± 0.2
1-S56-A	0.20 ± 0.04	<0.06	0.15 ± 0.05	<1.0	<0.7
B	0.03 ± 0.04	0.17 ± 0.05	<0.02	<1.0	<0.7
C	0.21 ± 0.04	0.34 ± 0.06	0.53 ± 0.05	<1.0	<0.7
D	0.13 ± 0.04	1.05 ± 0.11	1.35 ± 0.14	2.0 ± 0.2	1.4 ± 0.2
1-S57-A	5.01 ± 0.50	<0.06	0.91 ± 0.09	2.1 ± 0.2	1.4 ± 0.2
B	7.80 ± 0.78	0.80 ± 0.08	1.15 ± 0.12	1.8 ± 0.2	1.2 ± 0.2
C	2.35 ± 0.24	1.07 ± 0.11	1.12 ± 0.11	1.7 ± 0.2	1.2 ± 0.2
D	0.99 ± 0.10	0.70 ± 0.07	1.20 ± 0.12	2.1 ± 0.2	1.4 ± 0.2
1-S58-A	1.44 ± 0.14	1.38 ± 0.14	0.80 ± 0.08	1.9 ± 0.2	1.3 ± 0.2
B	1.65 ± 0.17	0.94 ± 0.09	0.88 ± 0.09	1.9 ± 0.2	1.3 ± 0.2
C	0.93 ± 0.09	1.10 ± 0.11	1.24 ± 0.12	1.8 ± 0.2	1.2 ± 0.2
D	0.45 ± 0.05	1.06 ± 0.11	1.01 ± 0.10	1.7 ± 0.2	1.2 ± 0.2

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[a]			Uranium Fluorometric	
	^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	μg/g ± 10%	pCi/g ± 10%
1-S59-A	1.55 ± 0.16	1.31 ± 0.13	1.86 ± 0.19	4.2 ± 0.4	2.9 ± 0.3
B	2.74 ± 0.27	1.18 ± 0.12	1.72 ± 0.17	4.8 ± 0.5	3.3 ± 0.3
C	2.27 ± 0.23	0.68 ± 0.07	1.46 ± 0.15	3.6 ± 0.4	2.5 ± 0.3
D	0.33 ± 0.04	1.11 ± 0.11	2.01 ± 0.20	3.6 ± 0.4	2.5 ± 0.3
1-S60-A	5.19 ± 0.52	1.47 ± 0.15	2.07 ± 0.21	3.9 ± 0.4	2.7 ± 0.3
B	3.48 ± 0.35	2.19 ± 0.22	3.39 ± 0.34	6.9 ± 0.7	4.7 ± 0.5
C	0.78 ± 0.08	3.32 ± 0.33	4.85 ± 0.49	8.9 ± 0.9	6.1 ± 0.6
D	0.20 ± 0.04	1.09 ± 0.11	1.45 ± 0.15	2.5 ± 0.3	1.7 ± 0.2
1-S61-A	0.97 ± 0.10	1.15 ± 0.12	0.81 ± 0.08	2.3 ± 0.2	1.6 ± 0.2
B	0.62 ± 0.06	1.39 ± 0.14	0.73 ± 0.07	2.5 ± 0.3	1.7 ± 0.2
C	0.61 ± 0.06	0.88 ± 0.09	0.76 ± 0.08	2.6 ± 0.3	1.8 ± 0.2
D	0.95 ± 0.10	1.03 ± 0.16	0.84 ± 0.08	3.0 ± 0.3	2.1 ± 0.2
1-S62-A	1.10 ± 0.11	1.59 ± 0.16	1.10 ± 0.11	27.0 ± 2.7	11.8 ± 1.2[c]
B	0.50 ± 0.05	0.80 ± 0.08	1.67 ± 0.17	15.5 ± 1.6	7.6 ± 0.8[c]
C	0.11 ± 0.03	1.28 ± 0.13	1.20 ± 0.12	4.6 ± 0.5	3.2 ± 0.3
D	<0.03	0.90 ± 0.09	1.21 ± 0.12	2.5 ± 0.3	1.7 ± 0.2
1-S75[d]	1.63 ± 0.16	0.07 ± 0.04	1.34 ± 0.13	1.9 ± 0.2	1.3 ± 0.2
1-S76[e]	0.48 ± 0.05	1.75 ± 0.18	3.84 ± 0.38	962.0 ±96.0	390.0 ±39.0[b]
SOIL BORINGS					
1-S77-1	0.23 ± 0.04	0.58 ± 0.06	0.72 ± 0.07	3.5 ± 0.4	2.0 ± 0.2[c]
2	0.30 ± 0.04	0.73 ± 0.07	0.43 ± 0.04	3.8 ± 0.4	1.9 ± 0.2[c]
4	0.34 ± 0.04	0.49 ± 0.05	0.36 ± 0.04	1.1 ± 0.1	0.8 ± 0.1
5	0.51 ± 0.05	1.21 ± 0.12	0.78 ± 0.08	2.6 ± 0.3	1.8 ± 0.2
6	0.17 ± 0.04	0.83 ± 0.08	0.74 ± 0.07	2.6 ± 0.3	1.8 ± 0.2

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[a] ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric μg/g ± 10%	Uranium Fluorometric pCi/g ± 10%
1-S78-1	0.35 ± 0.04	2.29 ± 0.23	2.42 ± 0.24	11.2 ± 1.1	6.5 ± 0.7[c]
2	0.57 ± 0.06	1.14 ± 0.11	1.11 ± 0.11	8.3 ± 0.8	4.3 ± 0.4[c]
3	0.57 ± 0.06	3.66 ± 0.37	2.32 ± 0.23	7.5 ± 0.8	5.1 ± 0.5
4	0.21 ± 0.03	1.98 ± 0.20	1.69 ± 0.17	3.0 ± 0.3	2.0 ± 0.2
5	0.24 ± 0.03	1.76 ± 0.18	1.76 ± 0.18	3.2 ± 0.3	2.2 ± 0.2
6	0.25 ± 0.04	1.82 ± 0.18	1.69 ± 0.17	3.6 ± 0.4	2.5 ± 0.3
1-S79-1	0.53 ± 0.05	1.65 ± 0.17	1.78 ± 0.18	22.5 ± 2.3	10.6 ± 1.1[c]
2	0.44 ± 0.04	1.29 ± 0.13	1.15 ± 0.12	4.9 ± 0.5	2.9 ± 0.3[c]
3	0.18 ± 0.04	0.15 ± 0.05	0.29 ± 0.03	0.9 ± 0.1	0.6 ± 0.1
4	1.70 ± 0.17	0.33 ± 0.07	0.68 ± 0.07	1.3 ± 0.1	0.9 ± 0.1
5	<0.03	0.23 ± 0.04	0.60 ± 0.06	2.0 ± 0.2	1.4 ± 0.1
6	<0.03	1.15 ± 0.12	0.69 ± 0.07	1.6 ± 0.2	1.1 ± 0.1
1-S80-1	0.36 ± 0.04	0.89 ± 0.09	1.07 ± 0.11	23.3 ± 2.3	10.3 ± 1.0[c]
2	<0.03	1.85 ± 0.19	2.10 ± 0.21	6.7 ± 0.7	4.4 ± 0.4[c]
3	<0.03	<0.06	0.48 ± 0.05	1.7 ± 0.2	1.2 ± 0.1[c]
4	<0.03	0.68 ± 0.07	0.38 ± 0.04	4.1 ± 0.4	2.0 ± 0.2[c]
5	1.35 ± 0.14	1.01 ± 0.10	1.48 ± 0.15	7.0 ± 0.7	4.0 ± 0.4[c]
6	0.22 ± 0.02	0.98 ± 0.10	0.60 ± 0.06	7.4 ± 0.7	3.5 ± 0.4[c]
1-S81-1	0.20 ± 0.04	0.95 ± 0.10	1.41 ± 0.14	622.0 ± 62.2	252.0 ±25.2[b]
2	0.77 ± 0.08	0.24 ± 0.02	1.36 ± 0.14	1400.0 ±140.0	567.0 ±56.7[b]
4	0.22 ± 0.04	0.60 ± 0.06	1.44 ± 0.14	232.0 ± 23.2	94.0 ± 9.4[b]
5	0.34 ± 0.03	0.78 ± 0.08	0.83 ± 0.08	101.0 ± 10.1	40.9 ± 4.1[b]
6	<0.03	0.60 ± 0.06	1.19 ± 0.12	14.2 ± 1.4	6.7 ± 0.7[b]
1-S82-1	0.57 ± 0.06	1.32 ± 0.13	1.06 ± 0.11	119.0 ± 12.0	48.2 ± 4.8[b]
2	0.51 ± 0.05	1.42 ± 0.14	1.15 ± 0.12	62.4 ± 6.2	25.3 ± 2.5[b]
3	0.88 ± 0.09	1.18 ± 0.12	1.17 ± 0.12	54.3 ± 5.4	22.0 ± 2.2[b]
4	0.21 ± 0.02	1.35 ± 0.14	0.74 ± 0.07	10.4 ± 1.0	4.8 ± 0.5[c]
5	0.21 ± 0.02	0.25 ± 0.05	0.36 ± 0.04	2.0 ± 0.2	1.4 ± 0.2
6	0.25 ± 0.02	0.63 ± 0.06	0.79 ± 0.08	1.6 ± 0.2	1.1 ± 0.1

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[10] ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric μg/g ± 10%	Uranium Fluorometric pCi/g ± 10%
1-S83-1	0.08 ± 0.05	0.60 ± 0.06	1.13 ± 0.11	136.0 ± 13.6	55.1 ± 5.5[b]
2	0.37 ± 0.04	0.61 ± 0.06	1.56 ± 0.16	928.0 ± 92.8	376.0 ±37.6[b]
3	<0.03	0.31 ± 0.09	0.60 ± 0.06	33.4 ± 3.4	13.5 ± 1.4[b]
4	<0.03	0.34 ± 0.07	0.83 ± 0.08	15.2 ± 1.5	6.8 ± 0.7[c]
5	<0.03	0.13 ± 0.05	1.04 ± 0.10	39.0 ± 3.9	15.8 ± 1.6[b]
6	0.08 ± 0.05	0.46 ± 0.07	0.99 ± 0.10	35.9 ± 3.6	14.5 ± 1.5[b]
1-S84-1	0.90 ± 0.09	0.89 ± 0.09	1.06 ± 0.11	257.0 ± 26.0	104.0 ±10.4[b]
2	0.35 ± 0.04	1.07 ± 0.01	1.35 ± 0.14	136.0 ± 14.0	55.1 ± 5.5[b]
3	0.63 ± 0.06	1.14 ± 0.11	0.28 ± 0.03	8.9 ± 0.9	3.6.± 0.4[b]
5	0.13 ± 0.03	0.73 ± 0.07	0.91 ± 0.09	6.1 ± 0.6	3.2 ± 0.3[c]
6	<0.03	0.58 ± 0.09	1.01 ± 0.10	5.8 ± 0.6	3.2 ± 0.3[c]4
1-S85-1	3.62 ± 0.4	0.94 ± 0.09	0.68 ± 0.07	710.0 ± 71.0	288.0 ±28.8[b]
2	0.68 ± 0.07	1.75 ± 0.18	1.62 ± 0.16	1452.0 ±145.2	588.0 ±58.8[b]
3	0.47 ± 0.05	3.81 ± 0.38	2.42 ± 0.24	254.0 ± 25.4	70.1 ± 7.0[b]
4	0.23 ± 0.02	0.40 ± 0.08	1.00 ± 0.10	27.4 ± 2.7	11.1 ± 1.1[b]
5	0.38 ± 0.04	1.46 ± 0.15	1.07 ± 0.11	18.9 ± 1.9	7.6 ± 0.8[b]
6	0.47 ± 0.05	0.62 ± 0.06	0.78 ± 0.08	10.1 ± 1.0	4.1 ± 0.4[b]
1-S86-1	0.57 ± 0.06	0.36 ± 0.07	0.78 ± 0.08	393.0 ± 39.3	159.0 ±15.9[b]
2	1.18 ± 0.12	0.57 ± 0.09	1.41 ± 0.14	597.0 ± 59.7	242.0 ±24.2[b]
3	0.55 ± 0.06	1.12 ± 0.11	1.04 ± 0.10	33.5 ± 3.4	13.6 ± 1.4[b]
4	<0.03	1.18 ± 0.12	1.25 ± 0.12	19.9 ± 2.0	8.1 ± 0.8[b]
5	0.03 ± 0.02	0.84 ± 0.08	1.30 ± 0.13	8.2 ± 0.8	4.4 ± 0.4[b]
6	<0.03	0.56 ± 0.08	0.90 ± 0.09	2.4 ± 0.2	1.6 ± 0.2
1-S87-1	1.00 ± 0.10	1.74 ± 0.17	11.02 ± 1.10	14.1 ± 1.4	9.6 ± 1.0
2	0.19 ± 0.02	1.03 ± 0.10	1.72 ± 0.17	2.4 ± 0.2	1.6 ± 0.2
3	0.42 ± 0.04	1.56 ± 0.16	2.11 ± 0.21	4.5 ± 0.5	3.1 ± 0.3
4	0.15 ± 0.04	2.21 ± 0.22	2.32 ± 0.23	5.7 ± 0.6	3.9 ± 0.4
5	0.15 ± 0.04	2.15 ± 0.22	2.44 ± 0.24	5.8 ± 0.6	4.0 ± 0.4
6	0.13 ± 0.03	2.35 ± 0.24	2.05 ± 0.20	4.4 ± 0.4	3.0 ± 0.3

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[a]			Uranium Fluorometric	
	^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	μg/g ± 10%	pCi/g ± 10%
1-S88-1	0.76 ± 0.08	0.65 ± 0.06	1.03 ± 0.10	9.0 ± 0.9	4.5 ± 0.4[c]
2	0.29 ± 0.04	1.40 ± 0.14	1.06 ± 0.11	4.8 ± 0.5	2.8 ± 0.3[c]
3	1.24 ± 0.12	0.33 ± 0.10	1.21 ± 0.12	3.0 ± 0.3	2.0 ± 0.2
4	0.36 ± 0.04	0.98 ± 0.10	0.93 ± 0.09	2.9 ± 0.3	2.0 ± 0.2
5	0.61 ± 0.06	2.04 ± 0.20	1.77 ± 0.18	3.8 ± 0.4	2.6 ± 0.3
6	1.19 ± 0.12	2.18 ± 0.22	2.65 ± 0.26	3.7 ± 0.4	2.5 ± 0.3
1-S89-1	0.15 ± 0.04	0.57 ± 0.09	0.56 ± 0.06	8.7 ± 0.9	4.0 ± 0.4[c]
2	0.16 ± 0.04	0.08 ± 0.04	0.40 ± 0.04	5.5 ± 0.6	2.6 ± 0.3[c]
3	<0.03	0.48 ± 0.07	0.89 ± 0.09	3.2 ± 0.3	2.2 ± 0.2
4	0.11 ± 0.03	0.50 ± 0.08	0.89 ± 0.09	2.1 ± 0.2	1.4 ± 0.1
5	0.33 ± 0.04	0.67 ± 0.07	0.75 ± 0.08	1.8 ± 0.2	1.2 ± 0.1
6	0.33 ± 0.04	0.83 ± 0.08	0.99 ± 0.10	2.4 ± 0.2	1.6 ± 0.2
1-S90-1	1.50 ± 0.15	1.14 ± 0.11	1.07 ± 0.11	42.3 ± 4.2	17.1 ± 1.7[b]
2	0.21 ± 0.04	0.70 ± 0.07	0.82 ± 0.08	6.6 ± 0.7	3.3 ± 0.3[c]
3	0.15 ± 0.04	0.47 ± 0.09	0.73 ± 0.07	3.7 ± 0.4	2.1 ± 0.2[c]
4	<0.03	0.71 ± 0.07	0.75 ± 0.08	1.4 ± 0.2	1.0 ± 0.1
5	0.14 ± 0.04	1.12 ± 0.11	0.85 ± 0.08	1.8 ± 0.2	1.2 ± 0.1
6	0.06 ± 0.02	<0.06	0.78 ± 0.08	1.7 ± 0.2	1.2 ± 0.1
1-S91-1	0.44 ± 0.04	2.96 ± 0.30	3.61 ± 0.36	11.6 ± 1.2	7.9 ± 0.8
2	0.03 ± 0.02	1.13 ± 0.11	0.91 ± 0.09	2.5 ± 0.3	1.7 ± 0.2
3	<0.03	1.43 ± 0.14	1.29 ± 0.13	2.8 ± 0.3	1.9 ± 0.2
4	<0.03	2.21 ± 0.22	1.70 ± 0.17	3.7 ± 0.4	2.5 ± 0.3
5	<0.03	0.43 ± 0.06	0.39 ± 0.04	2.2 ± 0.2	1.5 ± 0.2
6	<0.03	1.72 ± 0.17	1.02 ± 0.10	4.4 ± 0.5	3.0 ± 0.3

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[10] ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric µg/g ± 10%	Uranium Fluorometric pCi/g ± 10%
1-S92-1	BDL[g]	2.84 ± 0.28	13.66 ± 1.37	1.4 ± 0.2	1.0 ± 0.1
2	0.19 ± 0.06	2.08 ± 0.21	11.67 ± 1.17	2.5 ± 0.3	1.7 ± 0.2
3	0.14 ± 0.04	0.94 ± 0.09	4.44 ± 0.44	2.3 ± 0.2	1.6 ± 0.2
4	0.09 ± 0.04	0.93 ± 0.09	1.98 ± 0.20	1.9 ± 0.2	1.3 ± 0.1
5	BDL	0.35 ± 0.07	0.97 ± 0.10	1.0 ± 0.1	0.7 ± 0.1
6	BDL	0.55 ± 0.08	0.87 ± 0.09	1.2 ± 0.1	0.8 ± 0.1
1-S93-1	0.25 ± 0.04	0.79 ± 0.08	1.65 ± 0.16	2.7 ± 0.3	1.8 ± 0.2
2	0.22 ± 0.04	0.92 ± 0.09	1.34 ± 0.13	2.0 ± 0.2	1.4 ± 0.2
3	0.04 ± 0.02	1.10 ± 0.11	1.32 ± 0.13	2.3 ± 0.2	1.6 ± 0.2
4	<0.03	0.83 ± 0.08	0.95 ± 0.10	2.9 ± 0.3	2.0 ± 0.2
5	<0.03	1.06 ± 0.11	1.72 ± 0.17	3.3 ± 0.3	2.3 ± 0.2
6	0.03 ± 0.02	0.95 ± 0.10	1.28 ± 0.13	2.7 ± 0.3	1.8 ± 0.2
1-S94-1	0.63 ± 0.06	2.08 ± 0.21	5.54 ± 0.55	17.8 ± 1.8	12.2 ± 1.2
2	0.03 ± 0.02	1.63 ± 0.16	7.99 ± 0.80	10.3 ± 1.0	7.0 ± 0.7
3	0.17 ± 0.05	1.15 ± 0.12	3.44 ± 0.34	14.1 ± 1.4	9.6 ± 1.0
4	<0.03	-	1.46 ± 0.15	2.4 ± 0.2	1.6 ± 0.2
5	<0.03	0.77 ± 0.08	1.23 ± 0.12	1.8 ± 0.2	1.2 ± 0.1
6	<0.03	0.58 ± 0.09	1.85 ± 0.18	2.4 ± 0.2	1.6 ± 0.2
1-S95-1	0.55 ± 0.06	2.18 ± 0.22	5.04 ± 0.50	2.6 ± 0.3	1.8 ± 0.2
2	0.12 ± 0.04	1.88 ± 0.19	4.24 ± 0.42	2.9 ± 0.3	2.0 ± 0.7
3	0.28 ± 0.04	1.76 ± 0.18	4.14 ± 0.41	2.3 ± 0.2	1.6 ± 0.2
4	0.09 ± 0.04	0.97 ± 0.10	2.41 ± 0.24	4.1 ± 0.4	2.8 ± 0.3
5	0.15 ± 0.04	0.31 ± 0.03	2.09 ± 0.21	4.3 ± 0.4	2.9 ± 0.3
6	<0.03	1.00 ± 0.10	4.18 ± 0.42	13.5 ± 1.4	9.2 ± 0.9
1-R96[f]	BDL	274.0 ±27.0	215.0 ±22.0	708.0 ± 71.0	483.0 ±48

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g±σ			Uranium Fluorometric	
	^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	μg/g ± 10%	pCi/g ± 10%
1-S97-A	0.84 ± 0.08	0.85 ± 0.08	1.01 ± 0.10	3.4 ± 0.3	2.3 ± 0.2
B	0.24 ± 0.05	1.11 ± 0.11	1.07 ± 0.11	3.4 ± 0.3	2.3 ± 0.2
C	0.16 ± 0.05	0.92 ± 0.09	1.24 ± 0.12	2.4 ± 0.2	1.6 ± 0.2
D	0.30 ± 0.04	0.95 ± 0.10	1.45 ± 0.14	2.6 ± 0.3	1.8 ± 0.2
1-S98-A	1.39 ± 0.14	0.70 ± 0.07	0.88 ± 0.09	3.3 ± 0.3	2.1 ± 0.2[c]
B	0.78 ± 0.08	0.84 ± 0.08	0.85 ± 0.08	6.0 ± 0.6	3.1 ± 0.3[c]
C	0.35 ± 0.04	0.64 ± 0.06	0.48 ± 0.05	7.6 ± 0.8	3.5 ± 0.4[c]
D	0.26 ± 0.04	1.09 ± 0.11	0.82 ± 0.04	7.5 ± 0.8	3.7 ± 0.4[c]
1-S99-A	0.47 ± 0.05	1.82 ± 0.18	2.04 ± 0.20	251.0 ± 25.1	102.0 ±10.2[b]
B	0.16 ± 0.05	2.45 ± 0.24	4.08 ± 0.41	322.0 ± 32.2	130.0 ±13.0[b]
C	0.16 ± 0.05	2.25 ± 0.22	5.89 ± 0.59	545.0 ± 54.5	221.0 ±22.1[b]
D	<0.03	1.16 ± 0.12	5.42 ± 0.54	272.0 ± 27.2	110.0 ±11.0[b]
1-S100-A	1.17 ± 0.12	1.75 ± 0.18	2.10 ± 0.21	5.3 ± 0.5	3.6 ± 0.4
B	0.66 ± 0.07	1.90 ± 0.19	2.06 ± 0.21	5.8 ± 0.6	4.0 ± 0.4
C	0.60 ± 0.06	2.22 ± 0.22	1.95 ± 0.20	8.8 ± 0.9	3.6 ± 0.4[c]
D	0.69 ± 0.07	3.70 ± 0.37	3.09 ± 0.31	8.3 ± 0.8	3.4 ± 0.4[c]
1-S101-A	0.51 ± 0.05	0.86 ± 0.09	0.77 ± 0.08	4.5 ± 0.5	3.1 ± 0.3
B	0.05 ± 0.02	1.15 ± 0.12	1.01 ± 0.10	3.0 ± 0.3	2.0 ± 0.2
C	0.21 ± 0.04	1.24 ± 0.12	0.90 ± 0.09	3.8 ± 0.4	2.6 ± 0.3
D	0.34 ± 0.05	1.00 ± 0.10	1.25 ± 0.12	3.3 ± 0.2	2.3 ± 0.2
1-S102[e]	1.55 ± 0.16	1.29 ± 0.13	3.06 ± 0.31	12.8 ± 1.3	7.7 ± 0.8[c]
1-S103[h]-A	3.82 ± 0.38	0.94 ± 0.09	1.73 ± 0.17	1.75×10^4 ± 1.75×10^3	7.1×10^3 ± 7.1×10^2[b]
B	1.48 ± 0.15	-	1.10 ± 0.11	2.73×10^3 ± 2.73×10^2	1.1×10^3 ± 1.1×10^2[b]
C	0.18 ± 0.05	1.09 ± 0.11	1.40 ± 0.14	463.0 ± 46.3	188.0 ±18.8[b]
D	0.07 ± 0.04	1.30 ± 0.13	1.65 ± 0.16	343.0 ± 34.3	139.0 ±13.9[b]
E	<0.03	1.22 ± 0.12	2.17 ± 0.22	146.0 ± 14.6	59.1 ± 5.9[b]

TABLE 4
(cont'd.)

Sample No.	Gamma Spectra, pCi/g[a] ^{137}Cs	^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric µg/g ± 10%	Uranium Fluorometric pCi/g ± 10%
1-S104-A	3.13 ± 0.31	BDL	1.88 ± 0.19	3.10×10^{3} ± 3.1×10^{2}	1.3×10^{3} ± 1.3×10^{2}[b]
B	1.01 ± 0.10	BDL	1.34 ± 0.13	6.39×10^{4} ± 6.4×10^{3}	2.6×10^{4} ± 2.6×10^{3}[b]
C	2.14 ± 0.21	0.72 ± 0.07	1.23 ± 0.12	5.26×10^{3} ± 5.3×10^{2}	2.1×10^{3} ± 2.1×10^{2}[b]
1-S105[e]	2.53 ± 0.25	0.30 ± 0.09	1.45 ± 0.14	1.67×10^{4} ± 1.7×10^{3}	6.8×10^{3} ± 6.8×10^{2}[b]
1-S106[e]	2.62 ± 0.26	0.85 ± 0.08	1.05 ± 0.10	1.67×10^{4} ± 1.7×10^{3}	6.8×10^{3} ± 6.8×10^{2}[b]
BACKGROUND SOIL ENVIRONMENTAL					
1-SB107-A	1.25 ± 0.06	1.2 ± 0.1	0.96 ± 0.06	3.4 ± 0.5	2.3 ± 0.[illegible]
B				4.3 ± 0.6	2.9 ± 0.4
C				4.1 ± 0.6	2.8 ± 0.4
D				3.1 ± 0.4	2.1 ± 0.[illegible]
1-SB108-A	0.91 ± 0.05	1.5 ± 0.1	1.00 ± 0.07	2.5 ± 0.5	1.7 ± 0.3
B				6.8 ± 0.6	4.6 ± 0.4
C				3.5 ± 0.5	2.4 ± 0.3
D				3.2 ± 0.4	2.2 ± 0.3
1-SB109-A	2.20 ± 0.10	0.9 ± 0.1	0.68 ± 0.06	2.5 ± 0.4	1.7 ± 0.3
B				2.2 ± 0.4	1.5 ± 0.3
C				1.3 ± 0.4	0.9 ± 0.3
D				2.4 ± 0.4	1.6 ± 0.3
1-SB110-A	<0.05	0.91 ± 0.1	0.72 ± 0.06	4.0 ± 0.4	2.7 ± 0.3
B				17.4 ± 0.8	11.8 ± 0.5
C				5.0 ± 0.4	3.4 ± 0.3
D				3.2 ± 0.4	2.2 ± 0.3

TABLE 4
(cont'd.)

[a]Conversion per Appendix 5.

[b]Depleted uranium conversion factor of 0.406 pCi/g based on abundances given in Table 6.

[c]Depleted uranium corrected for natural uranium based on ^{226}Ra concentration.

[d]Soil from sewer (see Fig. 14).

[e]Surface scrapings.

[f]Rock sample from surface (see Fig. 8).

[g]BDL = Below Detectable Limits

[h]Sample subdivided into 2-in, 2-in, 2-in, 6-in, and 1-in segments.

TABLE 5

GAMMA SPECTRAL AND URANIUM FLUOROMETRIC ANALYSES OF WATER (W) AND SLUDGE (SS) SAMPLES

Sample No.	Volume (mℓ)	Gamma Spectra (pCi/mℓ±σ) ^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric μg/mℓ±10%	pCi/mℓ±10%[a]
			DISSOLVED SOLIDS		
1-W63	132	<0.01	<0.01	0.0011±0.0001	$7.5\times10^{-4}\pm7.5\times10^{-5}$
1-SS64	41	0.36±0.07	<0.01	0.0027±0.0003	$1.8\times10^{-3}\pm1.8\times10^{-4}$
1-SS65	43	BDL[b]	0.21±0.03	0.0012±0.0001	$8.2\times10^{-4}\pm8.2\times10^{-5}$
1-W66	147	<0.01	<0.01	0.0014±0.0001	$9.6\times10^{-4}\pm9.6\times10^{-5}$
1-W67	125	0.05±0.02	<0.01	0.0002±0.0001	$1.4\times10^{-4}\pm1.4\times10^{-5}$
1-SS68	42	BDL	0.09±0.03	0.0010±0.0001	$6.8\times10^{-4}\pm6.8\times10^{-5}$
1-W69	135	<0.01	<0.01	0.0007±0.0001	$2.8\times10^{-4}\pm2.8\times10^{-5}$[c]
1-SS70	58	0.05±0.02	<0.01	0.0022±0.0002	$1.5\times10^{-3}\pm1.5\times10^{-4}$
1-W71	135	<0.01	<0.01	0.0002±0.0001	$1.4\times10^{-4}\pm1.4\times10^{-5}$
1-SS72	85	0.04±0.01	<0.01	0.0012±0.0001	$8.2\times10^{-4}\pm8.2\times10^{-5}$
1-W73	132	0.12±0.05	<0.01	0.0008±0.0001	$5.5\times10^{-4}\pm5.5\times10^{-5}$
1-SS74	47	BDL	0.07±0.02	0.0006±0.0001	$4.1\times10^{-4}\pm4.1\times10^{-5}$
1-W86	135	0.04±0.02	0.03±0.02	0.0215±0.0022	$8.7\times10^{-3}\pm8.7\times10^{-4}$[c]
1-W90	38	BDL	<0.01	0.0011±0.0001	$7.5\times10^{-4}\pm7.5\times10^{-5}$
1-W91	147	BDL	0.02±0.01	0.0038±0.0004	$1.5\times10^{-3}\pm1.5\times10^{-4}$[c]
1-W92	137	BDL	<0.01	0.0035±0.0004	$2.4\times10^{-3}\pm2.4\times10^{-4}$
1-W93	134	<0.01	<0.01	0.0014±0.0002	$9.6\times10^{-4}\pm9.6\times10^{-5}$
1-W95	142	0.04±0.02	<0.01	0.0134±0.0013	$9.2\times10^{-4}\pm9.2\times10^{-5}$

TABLE 5
(cont'd.)

Sample No.	Weight (g)	Gamma Spectra (pCi/mℓ±σ) ^{232}Th Decay Chain	^{226}Ra Decay Chain	Uranium Fluorometric μg/g±10%	pCi/g±10%
			SUSPENDED SOLIDS		
1-W63	0.033	BDL	<0.02	3.0 ± 0.3	2.0 ± 0.2
1-SS64	109.2	1.00±0.10	<0.02	3.4 ± 0.3	2.3 ± 0.2
1-SS65	97.4	0.36±0.07	1.04±0.10	2.5 ± 0.3	1.7 ± 0.2
1-W66	0.027	<0.06	<0.02	3.3 ± 0.3	2.3 ± 0.2
1-W67	0.009	<0.06	6.4 ±0.64	2.4 ± 0.3	1.6 ± 0.2
1-SS68	159.0	0.61±0.06	0.60±0.06	1.2 ± 0.2	0.8 ± 0.1
1-W69	0.008	1.5 ±0.15	<0.02	6.8 ± 0.7	4.6 ± 0.5
1-SS70	165.5	0.46±0.07	0.82±0.08	1.8 ± 0.2	1.2 ± 0.1
1-W71	0.011	<0.06	<0.02	2.7 ± 0.3	1.8 ± 0.2
1-SS72	19.6	<0.06	2.46±0.25	2.2 ± 0.2	1.5 ± 0.2
1-W73	0.008	<0.06	<0.02	2.5 ± 0.3	1.7 ± 0.2
1-SS74	121.6	0.78±0.08	0.63±0.06	1.0 ± 0.1	0.7 ± 0.1
1-W86	12.3	<0.06	1.06±0.11	135.0 ±13.5	54.7 ± 5.5[c]
1-W90	109.1	0.65±0.06	0.85±0.08	4.4 ± 0.5	3.0 ± 0.3
1-W91	0.29	-	<0.02	10.3 ± 1.0	4.2 ± 0.4[c]
1-W92	10.2	2.03±0.20	1.26±0.13	2.8 ± 0.3	1.9 ± 0.2
1-W93	13.0	<0.06	1.80±0.18	5.1 ± 0.5	3.5 ± 0.4
1-W95	5.1	<0.06	7.11±0.71	5.1 ± 0.5	3.5 ± 0.4

[a] Conversion for Appendix 5.
[b] BDL = Below Detectable Limits
[c] Depleted uranium concentration factor of 0.405 as in Table 4.

TABLE 6

URANIUM MASS SPECTROMETRIC ANALYSES
OF SELECTED SOIL SAMPLES

Sample No.	U Isotopic, Atom % 233	234	235	236	238
1-S47-A	<0.001	0.001	0.228	0.005	99.766
D	<0.001	0.001	0.235	0.005	99.759
1-S48-A	<0.001	0.001	0.237	0.005	99.757
D	<0.001	0.001	0.273	0.005	99.271
1-S49-A	<0.001	0.001	0.230	0.005	99.764
D	<0.001	0.001	0.236	0.005	99.758
1-S50-A	<0.001	0.001	0.227	0.005	99.767
D	<0.001	0.001	0.228	0.005	99.766
1-S76	<0.001	0.001	0.226	0.005	99.768
1-S103-A	<0.001	0.001	0.226	0.005	99.768
1-S105-A	<0.001	0.001	0.225	0.006	99.768
1-R96	<0.001	0.005	0.711	<0.001	99.283

APPENDIX 1

INSTRUMENTATION

I. PORTABLE RADIATION SURVEY METERS

A. Gas-Flow Proportional Survey Meters

The Eberline PAC-4G-3 was the primary instrument used for surveying. This instrument is a gas-flow proportional counter which utilizes a propane gas-proportional detector, 51 cm^2 (AC-21) or 325 cm^2 (AC-22) in area, with a thin double-aluminized Mylar window (~ 0.85 mg/cm^2).

Since this instrument has multiple high-voltage settings, it can be used to distinguish between alpha and beta-gamma contamination. This instrument was initially used in the beta mode. In the beta mode, the detector responds to alpha and beta paticles and x- and gamma-rays. When areas indicated a higher count rate than the average instrument background, the beta-mode reading was recorded, and the instrument was then switched to the alpha mode to determine any alpha contribution. In the alpha mode, the instrument responds only to particles with high-specific ionization. This instrument is calibrated in the alpha mode with a flat-plate infinitely-thin NBS traceable ^{239}Pu standard, and in the beta mode with a flat-plate infinitely-thin NBS traceable ^{90}Sr-^{90}Y standard. The PAC-4G-3 instruments are calibrated to an apparent 50% detection efficiency. An input discriminator threshold sensitivity of 1.5 mV is used with these detectors.

B. Beta-Gamma End Window Survey Meter

When an area of contamination was found with a PAC instrument, a reading was taken with an Eberline Beta-gamma Geiger-Mueller Counter Model E-530 with a HP-190 probe. This probe has a thin mica end window and is, therefore, sensitive to alpha and beta particles and x- and gamma-rays. A thin piece of aluminum is added to the mica, thus making the window density ~7 mg/cm^2. At this density, the instrument is not sensitive to alpha particles. A maximum reading is obtained with the probe placed in contact with the area of contamination. In this position, the response (in mR/h) to gamma radiation is generally conservative relative to a determination of mrad/h at 1 cm. Another reading is obtained with the probe held 1 m from the contaminated area. This instrument is calibrated in mR/h with a ^{226}Ra standard source.

C. Low Energy Gamma Scintillation Survey Meter

An Eberline Model PRM-5-3 with a PG-2 gamma scintillation detector was used to determine low energy x and gamma radiation. The PG-2 detector consists of a thin NaI(Tℓ) scintillation crystal 5 cm in diameter by 2 mm thick. This instrument is calibrated on three separate discriminators for three energy regions using ^{239}Pu (17 keV), ^{241}Am (59.5 keV) and ^{235}U (185.7 keV) sources. This instrument can be operated in either a differential (to discriminate between different energy regions) or integral mode.

APPENDIX 1
(cont'd.)

D. High Energy Micro "R" Scintillation Survey Meter

An Eberline Micro "R" meter model PRM-7 was used to detect high-energy gamma radiation. This instrument contains an internally mounted NaI(Tℓ) scintillation crystal 2.5 cm in diameter by 2.5 cm thick and can be used for measuring fields of low-level radiation between 10 μR/h and 5000 μR/h. This instrument is also calibrated with a ^{226}Ra standard source.

E. Integrating Radiation Meter

In addition to the PRM-7, a pressurized ion chamber (Reuter Stokes Model RSS-111) was used at selected locations to determine the ambient radiation field. The RSS-111 has three output modes; (1) instantaneous exposure rate, (2) strip chart differential readout, and (3) integrated exposure. This instrument is mounted on a tripod, 3 ft (~ 1 m) above the surface and has a uniform energy response from about 0.2 MeV to about 4 MeV. A 3-h period of operation is usually sufficient to obtain significant data.

II. SMEAR COUNTING INSTRUMENTATION

An ANL-designed gas-flow proportional detector connected to an Eberline Mini Scaler Model MS-2 was used to count multiple smears simultaneously. This detector has a double-aluminized Mylar window (400 cm^2) and uses P-10 (90% argon and 10% methane) as the counting gas. The metal sample holder for this detector has been machined to hold ten smear papers. This particular system consists of two Mini Scalers and two detectors. One is used for counting in the alpha mode; the other is used in the beta mode. Up to ten samples can be counted simultaneously.

Any smear taken from a contaminated area was counted individually in a Nuclear Measurements Corporation (PC-5 or PC-3A) gas-flow proportional counter. These instruments have been modified to contain a double-aluminized Mylar spun top. This top is placed over non-conducting media (e.g. paper smears) to negate the dielectric effect on the counter. These counters also use P-10 counting gas. Smears are counted in both the alpha and beta modes. These instruments are calibrated by determining the input sensitivity using an alpha source.

III. AIR SAMPLING DEVICE

Air samples were collected using a commercially available (ANL-modified filter queen) vacuum cleaner identified as a "Princess Model." The air was drawn through a filter media at a flow rate of 40 m^3/h. The filter media consist of 200 cm^2 sheets of Hollingsworth-Vose (HV-70 or LB5211-9 mil) filter paper. The collection efficiency at these flow rates for 0.3-micron particles is about 99.9%.

A separate air sample can be taken with a positive displacement pump drawing about 20 liters/min through a millipore (0.5 to 0.8 micron) filter paper

for about one hour. An alpha spectrum can be measured from a section of this filter paper. The ratio of actinon (^{219}Rn - 6.62 MeV α AcC) to radon (^{222}Rn - 7.69 MeV α RaC') can be determined from this spectrum.

IV. GAMMA SPECTRAL INSTRUMENTATION

A Nuclear Data Multichannel Analyzer Model ND-100, utilizing a 7.6-cm-diameter by 7.6-cm-thick NaI(Tℓ) scintillation crystal is commonly used for determining gamma spectrum. This instrument is calibrated with NBS traceable gamma sources. Samples from contaminated areas were analyzed using this sytem and the contamination radionuclides were identified.

Hyperpure Germanium detectors (ORTEC - 17% efficiency right-circular cylinders) can be used when more sophisticated gamma-ray analyses are required. These detectors are coupled to Nuclear Data Multichannel Analyzers (Models ND-60, ND-66 or ND-100).

APPENDIX 2

CONVERSION FACTORS

I. INSTRUMENTATION

The factors used to convert the instrument readings to units of disintegrations per minute per 100 cm^2 (dis/min-100 cm^2) and the derivation of those factors are listed below.

A. Conversion Factors

	PAC-4G-3		Floor Monitor (FM-4G)	
	Alpha	Beta	Alpha	Beta
To 100 cm^2	1.96	1.96	0.31	0.31
cts/min per dis/min for ^{90}Sr-^{90}Y	-	2	-	2
cts/min per dis/min for ^{239}Pu	2	-	2	-
cts/min per dis/min for normal U	3.1	3.0	2.9	2.9
cts/min per dis/min ^{226}Ra plus daughters	1.6	1.7	1.6	1.7

B. Derivation of Conversion Factors

. Floor Monitor

Window Area: ~ 325 cm^2
Conversion to 100 cm^2 = 0.31 times Floor Monitor readings

. PAC-4G-3

Window Area: ~ 51 cm^2
Conversion to 100 cm^2 = 1.96 times PAC reading

. 2π Internal Gas-Flow Counter, PC counter

Geometry: Solid Steel Spun Top - 0.50

Geometry: Mylar Spun Top - 0.43
Mylar spun top counting {double-aluminized Mylar window (~ 0.85 mg/cm^2)} utilizes the well of the PC counter and is a method developed and used by the Argonne National Laboratory Health Physics Section for negating the dielectric effect in counting samples on nonconducting media.

APPENDIX 2
(cont'd.)

The PAC-4G-3 and PC counters are calibrated (see Appendix 1) using a flat-plate, infinitely thin ^{226}Ra (including all short-lived daughters) standard as a source of alpha emissions. The plate was counted in a 2π Internal Gas-Flow Counter (PC counter) with the source leveled to an apparent 2π geometry. The alpha counts per minute (cts/min) reading was found to be 1.9×10^4 cts/min, or $1.9 \times 10^4 \div 0.51^* = 3.8 \times 10^4$ disintegrations per minute (dis/min) alpha. Since the source was infinitely-thin, the alpha component was used as the total alpha dis/min of the source.

The same ^{226}Ra plus daughters source, when counted with the PAC instrument in the alpha mode, was found to be 2.3×10^4 cts/min at contact. The conversion factor for cts/min to dis/min for the PAC instrument is $3.8 \times 10^4 \div 2.3 \times 10^4 =$ 1.6 dis/min alpha to cts/min alpha.

The same source was covered with two layers of conducting paper, each 6.31 mg/cm^2, to absorb the alpha emissions. With the PC counter in the beta mode and the paper in good contrast with the chamber, the count was found to be 1.25×10^4 cts/min or $1.25 \times 10^4 \div 0.50 = 2.45 \times 10^4$ dis/min beta. With the PAC-4G-3 in the beta mode and in contact with the covered source in the center of the probe, the count was found to be 1.45×10^4 cts/min. This indicates a conversion factor of $2.45 \times 10^4 \div 1.45 \times 10^4 = 1.7$ dis/min alpha to cts/min beta-gamma. All three detectors (51 cm^2, 100 cm^2, and 325 cm^2) gave readings similar to those reported above for the alpha and beta-gamma mode.

A similar method was used to determine the conversion factors for normal uranium.

II. SMEAR COUNT

The conversion factors for cts/min-100 cm^2 to dis/min-100 cm^2 for smear counts are given below:

A. Conversion Equation (Alpha)

$$\frac{\text{cts/min} - (\text{Bkgd})}{g \times bf \times sa \times waf} = \text{dis/min } \alpha$$

A geometry (g) of 0.43 is standard for all flat-plate counting using the Mylar spun top.

A backscatter factor (bf) of 1.0 was used when determining alpha activity on a filter media.

The self-absorption factor (sa) was assumed to be 1, unless otherwise determined.

---

*The value of 0.51 includes the following factors: geometry (g) = 0.50; backscatter factor (bf) = 1.02; sample absorption factor (sa) = 1.0; window air factor (waf) = 1.0. The product of g x bf x sa x waf is 0.51.

APPENDIX 2
(Cont'd.)

If the energies of the isotope were known, the appropriate window air factor (waf) was used; if the energies of the isotopes were not known, the (waf) of ^{239}Pu (0.713) was used.

The (waf) for alpha from ^{226}Ra plus daughters is 0.55.

B. Conversion Equation (Beta)

$$\frac{\text{cts/min} - \{\beta \text{ Bkgd (cts/min)} + \alpha \text{ cts/min}\}}{g \times bf \times sa \times waf} = \text{dis/min } \beta$$

A geometry (g) of 0.43 is standard for all flat-plate counting using the Mylar spun top.

A backscatter factor (bf) of 1.1 was used when determining beta activity on a filter media.

A self-absorption factor (sa) was assumed to be 1, unless otherwise determined.

If the energies of the isotopes were known, the appropriate window air factor (waf) was used; if the energies of the isotopes were unknown, the (waf) of ^{90}Sr-^{90}Y (0.85) was used.

The (waf) for betas from ^{226}Ra plus daughters is 0.85.

APPENDIX D
CHEM-NUCLEAR SYSTEMS, INC. DATA

Comprehensive Site Assessment
General Services Administration (GSA)
Federal Property Resources Center
Watertown, Massachusetts

Volume IV

Radiological Survey Records

prepared by
Chem-Nuclear Systems, Inc.
O'Brien and Gere Engineers, Inc.

October 1990

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

14 JUN 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

15 JUN 90

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 16 JUN 90 | TIME START: 1535 | TIME COMPL: 1705 | PAGE 1 of 2

ACTIVITY/LOCATION: GSA-WATERTOWN (46-019), WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: N/A

MAP ID: 6-16-01

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ■ RADIATION SURVEY

COMMENTS: SURVEY OF SITE AREA INSIDE FENCE (EXCEPT BURN PIT). WALKOVER SURVEY TO ESTABLISH/VERIFY BACKGROUND AND WORKING LEVELS.

PERMISSIBLE LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

■ OTHER (SEE COMMENTS) ☐ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.	N/A	N/A	N/A
SOURCE STRENGTH	dpm	dpm	N/A mR/hr.
INSTRUMENT RESPONSE	cpm	cpm	N/A mR/hr.
EFFICIENCY/CORRECTION FACTOR			N/A
MDA*	dpm	dpm	SAT ■ UNSAT ☐
BACKGROUND	cpm	cpm	7.0 mR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA N/A	BETA-GAMMA N/A
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON N/A	BETA-GAMMA ESP-1 w/SPA-3 # 1116

RADCON REVIEW: [signature] DATE: 16 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ____ ■ SPECIAL ESTABLISH/VERIFY BACKGROUND AND WORKING LEVELS. ☐ ROUTINE ____

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV ___ dpm/PROBE	BETA-GAMMA EQUIV ___ dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1						LEVELS AND CORRESPONDING
2						LOCATIONS SHOWN ON MAP
3						6-16-01
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV ___ dpm/PROBE	BETA-GAMMA EQUIV ___ dpm/100 cm	mrem/hr. ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION
18						
19						
20						
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* THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS, INC

TO: PROJECT FILES

COMMENTS: SURVEY OF SITE AREA INSIDE FENCE (EXCEPT BURN PIT). WALKOVER SURVEY TO ESTABLISH/VERIFY BACKGROUND AND WARNING LEVELS.

ACTIVITY/LOCATION: G.S.A. WATERTOWN (46019) WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 2 OF 2

DATE: 16 JUN 90

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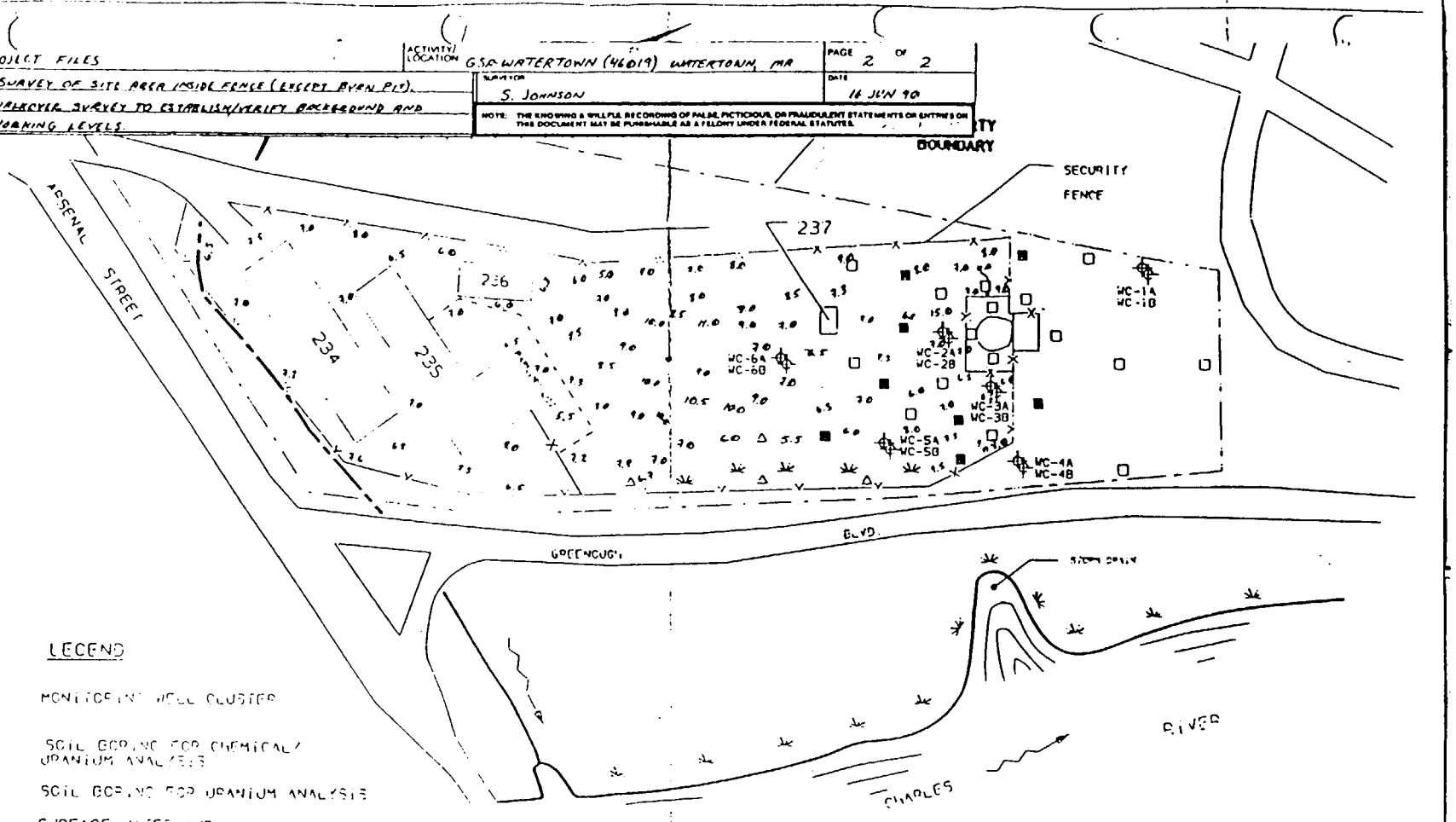

LEGEND

- MONITORING WELL CLUSTER
- SOIL BORING FOR CHEMICAL/URANIUM ANALYSIS
- SOIL BORING FOR URANIUM ANALYSIS
- SURFACE WATER AND SEDIMENT SAMPLE
- EXISTING DEPTH TO GROUND WATER SAMPLE

MAP I.D. NUMBER 6-16-01

CHEM-NUCLEAR SYSTEMS INC.

CONTAMINAT[illegible] [illegible]ADIATION SURVEY REPO[illegible]

TO: PROJECT FILE

[illegible]ATE: 17 JUN 90 | TIME START: 1510 | TIME COMPL: 1600 | PAGE 1 [illegible] 2

ACTIVITY/LOCATION: GSA-WATERTOWN
WATERTOWN MA
PROJECT #46017

SURVEYOR: S JOHNSON | PHONE: N/A

MAP ID: 6-17-01

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: ESTABLISH INITIAL CONTAMINATION/RADIATION LEVELS ON DRILL RIG PRIOR TO COMMENCING WORK.

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; ≤1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

■ OTHER (SEE COMMENTS) ☐ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	N/A
SOURCE STRENGTH	dpm	11771 dpm	N/A mR/hr.
INSTRUMENT RESPONSE	cpm	2331 cpm	N/A mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.20/5.0	N/A
MDA	dpm	92 dpm	SAT. ☒ UNSAT. ☐
BACKGROUND	cpm	35 cpm	7 ~~mR~~ μR/hr.

INSTRUMENT TYPE/TAG NO	ALPHA	BETA-GAMMA
CONTAMINATION SURVEY	N/A	ESP-1 #1116 HP-210
RADIATION SURVEY	NEUTRON: N/A	ESP-2 #803 SPA-3

RADCON REVIEW: [signature] (JOHNSON) DATE: 17 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ____ ☒ SPECIAL INITIAL PRE-WORK BASELINE SURVEY ☐ ROUTINE ____

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<92		6.0	LOCATIONS SHOWN
2			<92		6.5	ON MAP 6-17-01
3			<92		6.0	
4			<92		7.0	
5			<92		7.3	
6			<92		7.0	
7			<92		6.0	
8			<92		7.2	
9			<92		7.5	
10			<92		7.0	
11			<92		6.5	
12			<92		6.2	
13			<92		7.0	
14			<92		6.5	
15			<92		6.5	
16			<92		7.0	
17			<92		6.0	
18			<92		6.5	LOCATIONS SHOWN
19			<92		7.2	ON MAP 6-17-01
20			<92		6.3	
21			<92		7.0	
22			<92		7.0	
23			<92		6.0	
24						
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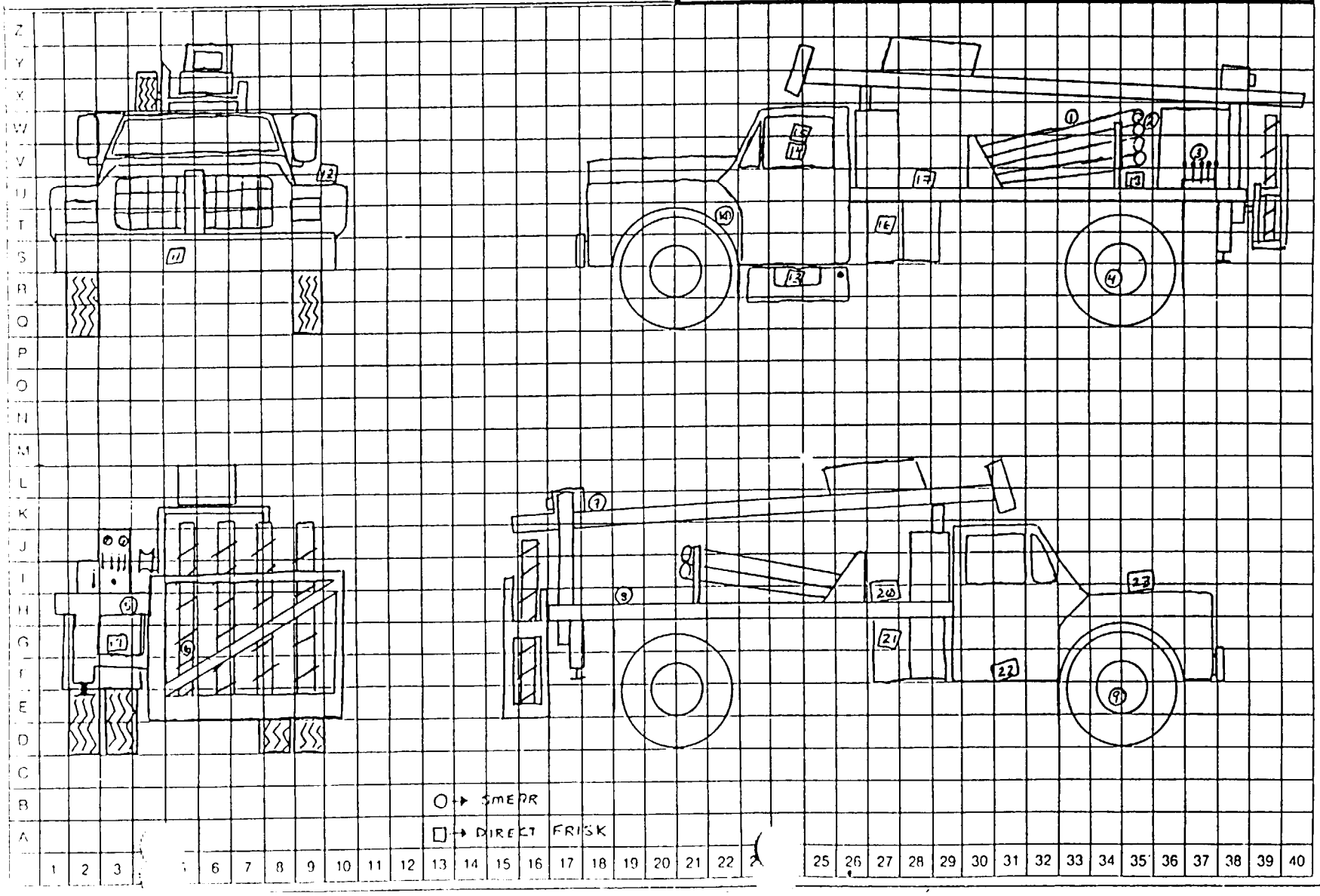
CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA- WATERTOWN (46019) WATERTOWN, MA.	PAGE 2 2	
COMMENTS: ESTABLISH INITIAL CONTAMINATION/RADIATION LEVELS ON DRILL RIG PRIOR TO COMMENCING WORK.	SURVEYOR: S. JOHNSON	DATE: 17 JUN 90	

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS, INC.

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-18-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 18 JUN 90

Sample Location SITE W-8A Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
N/A	N/A	N/A		N/A		6.0 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# #1116 ESP-1 C.F. 4.76 MDA 3.4×10^{-13}

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
729	20	36	37	0	$< 3.4 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 18 JUN 90 | TIME START: 1400 | TIME COMPL: 1700 | PAGE 1 / 2

ACTIVITY/LOCATION: GSA-WATERTOWN (46017) WATERTOWN MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-18-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: SURVEYS PERFORMED IN CONJUNCTION WITH DRILLING ACTIVITIES AT LOCATION W-9A.

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2807 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.20/5.0	—
MDA	dpm	100 dpm	SAT ■ UNSAT ☐
BACKGROUND	cpm	41 cpm	7 μR/hr

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA RM-20 1424	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON N/A	BETA-GAMMA ESP-2 #0803

RADCON REVIEW (JOHNSON) DATE 18 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE IN PROGRESS AND POST WORK

SWIPE/PROBE NO	ALPHA EQUIV dpm/PROBE	ALPHA EQUIV dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				<100	7.0	LOCATION SHOWN ON
2				<100	7.2	MAP 6-18-01
3				<100	6.5	
4				<100	7.0	
5				<100	6.8	
6				<100	7.5	
7				<100	7.0	
8				<100	6.8	
9				<100	7.3	
10				<100	7.5	
11				<100	7.0	
12				<100	6.0	
13				<100	6.5	
14				<100	6.8	
15				<100	7.0	
16				<100	6.5	
17				<100	7.3	
18				<100	7.6	LOCATION SHOWN ON
19				<100	8.0	MAP 6-18-01
20				<100	6.5	
21				<100	6.5	
22				<100	7.0	
23				<100	6.8	
24				<100	7.2	
25				<100	6.8	
26				<100	6.6	
27				<100	6.8	
28				<100	7.0	
29				<100	7.0	
30				<100	6.5	
31				<100	7.0	
32				<100	7.2	
33				<100	6.9	
34				<100	7.0	
35				<100	6.8	
36				<100	7.2	
37				<100	7.0	
38				<100	6.5	
39				<100	7.0	
40				<100	7.0	

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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILES

COMMENTS: DRILL SITE FOR DRILL LOCATION W-8A

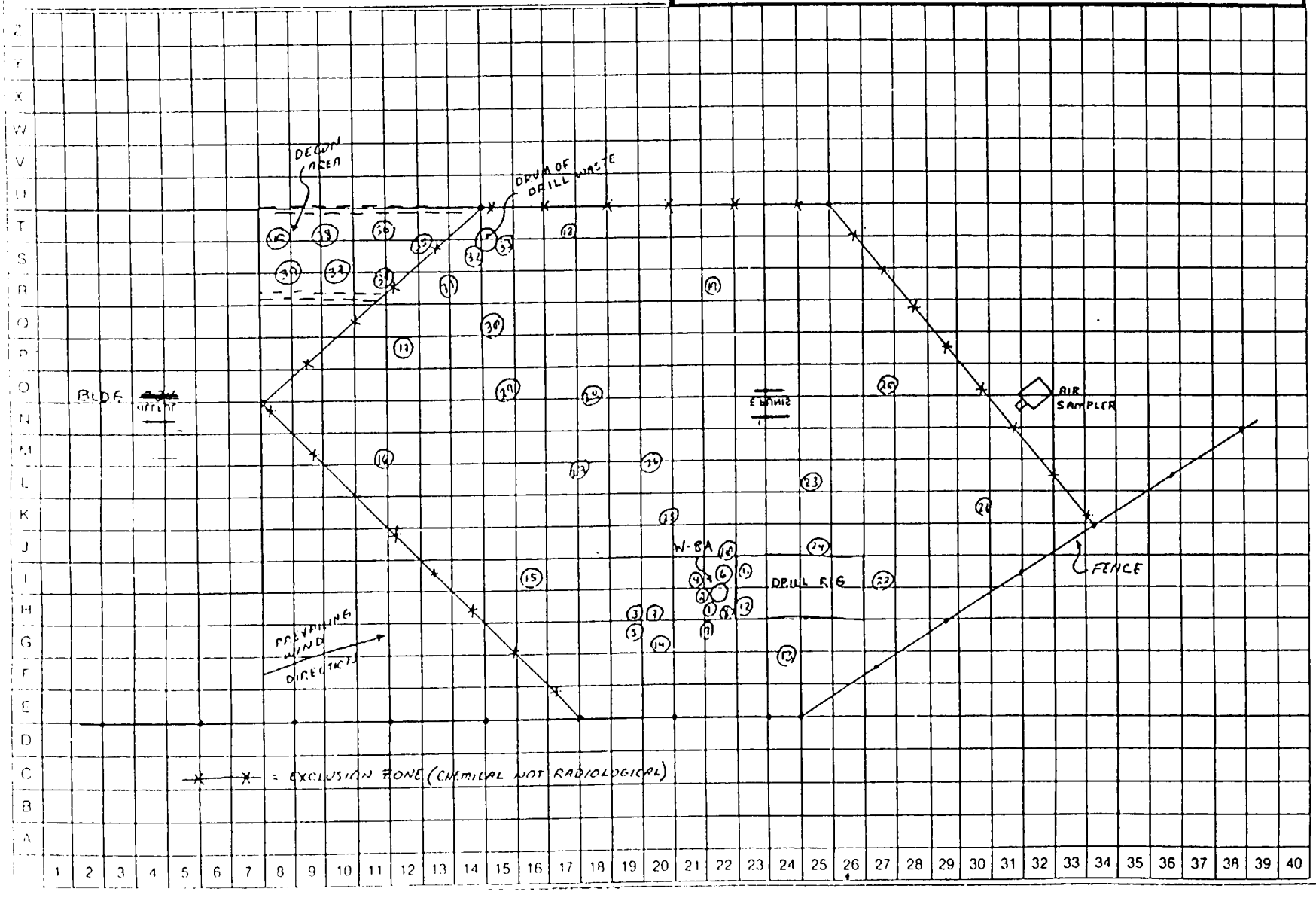
ACTIVITY/LOCATION: GSA-WATERTOWN (46017) WATERTOWN MA

PAGE: 2 2

SURVEYOR: S. JOHNSON

DATE: 18 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS, INC

CHEM-NUCLEAR SYSTEMS, INC.

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-19-01 (A)

Project Name/No. GSA-WATERTOWN/46019 Date 19 JUN 90

Sample Location SITE W-8A Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		10.0 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 1.89×10^{-12}

COUNTED 6-21-90 2038

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
304		10		30			34		0	$< 1.89 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location SITE W-10A Technician S. JOHNSON

Air Sampler/# RADECO/2055 Filter Used GELMAN A/E

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		10.35 m^3

β^- / γ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 1.82×10^{-12}

COUNTED 6-21-90

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
357		10		36			34		2	$< 1.82 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 19 JUN 90 | TIME START: 0930 | TIME COMPL: 1200 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA-WATERTOWN (46019) WATERTOWN MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-19-01

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE W-8A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; 1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ☒ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2391 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.20/5.0	—
MDA	dpm	94 dpm	SAT ☒ UNSAT ☐
BACKGROUND	cpm	37 cpm	7.0 μR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA N/A	BETA-GAMMA ESP-1 #1116	
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON N/A	BETA-GAMMA ESP-2 #0303	

RADCON REVIEW: [signature] DATE 19 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ☒ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
1					6.8	LOCATION SHOWN ON
2					7.0	MAP 6-19-01
3					6.6	
4					6.7	
5					7.0	
6					7.0	
7					7.5	
8					7.0	
9					7.0	
10					7.2	
11					6.8	
12					7.0	
13					6.5	
14						
18			<94		6.8	LOCATION SHOWN ON
19			<94		6.5	MAP 6-19-01
20					6.8	
21					7.2	
22					7.0	
23					7.3	
24					6.8	
25					7.0	
26			<94			
27			<94			
28			<94			
29			<94			
30			<94			
31			<94			
32			<94			
33			<94			
34			<94			
35			<94			
36			<94			

CHEM-NUCLEAR SYS

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE W-8A

ACTIVITY/LOCATION: GSA-WATERTOWN (46017) WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE: 3 3

DATE: 19 JUN 90

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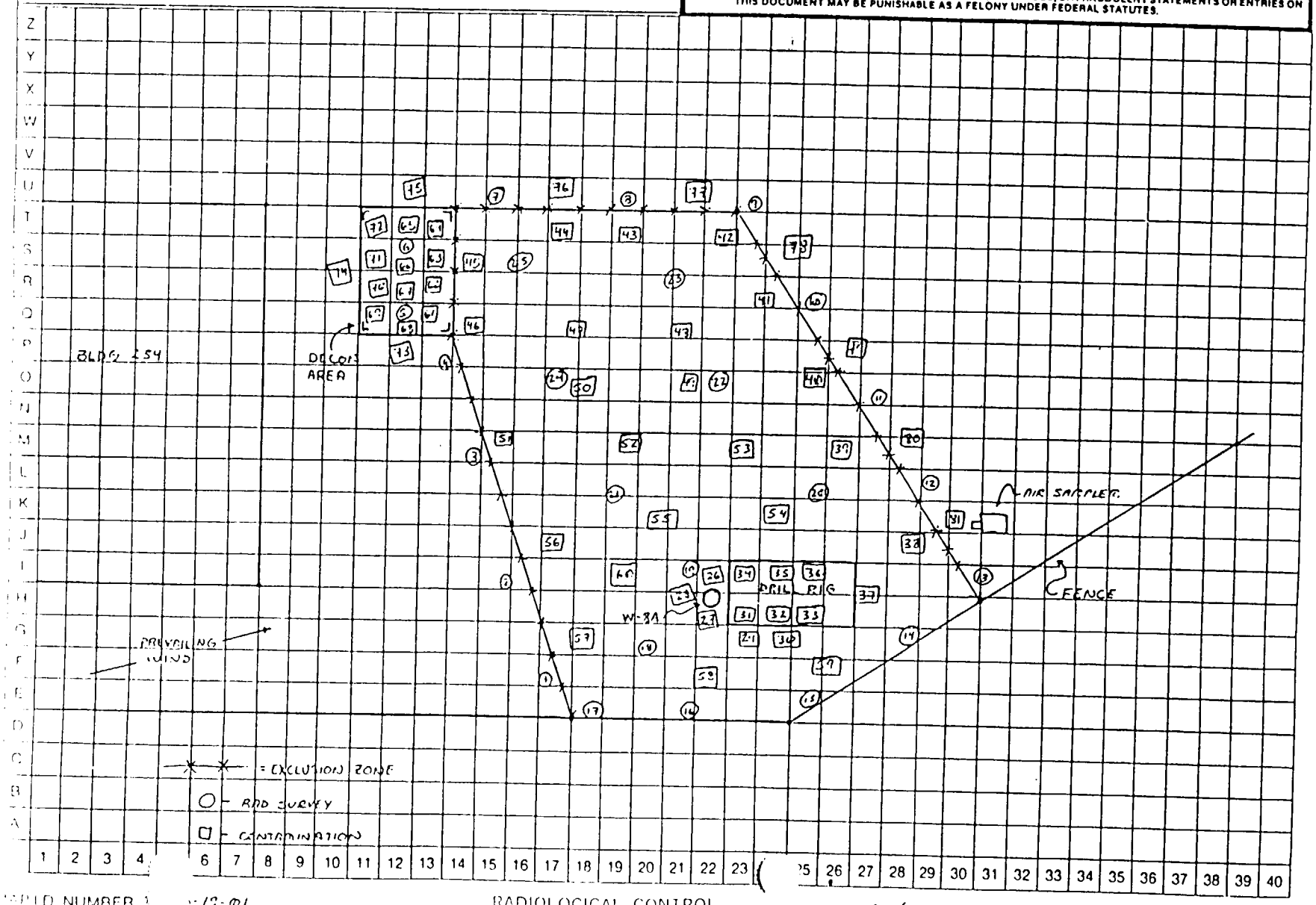

FORM NUMBER 3 [illegible] RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 19 JUN 90 | TIME START: 1430 | TIME COMPL: 1645 | PAGE 1 of 2

ACTIVITY/LOCATION: GSA INTERCHANGE (46019) WATERTOWN, MA

SURVEYOR: J. JOHNSON | PHONE: —

MAP ID: 6-19-02

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE W-10A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; 1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	
SOURCE STRENGTH	dpm	11771 dpm	mR/hr.
INSTRUMENT RESPONSE	cpm	2391 cpm	mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.2 / 5.0	
MDA*	dpm	94 dpm	SAT. ■ UNSAT ☐
BACKGROUND	cpm	37 cpm	7.0 mR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #0803

RADCON REVIEW: Scott L. [illegible] DATE: 19 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ BETA-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1					7.5	LOCATION SHOWN ON
2					7.0	MAP 6-19-02
3					7.8	
4					7.5	
5					7.5	
6			<94			
7			<94			
8			<94			
9			<94			
10			<94			
11			<94			
12			<94			
13			<94			
14			<94			
15			<94			
16			<94			
17					7.0	
18			<94			LOCATION SHOWN ON
19			<94			MAP 6-19-02
20			<94			
21			<94			
22			<94			
23			<94			
24			<94			
25			<94			
26			<94			
27			<94			
28			<94			
29			<94			
30			<94			
31			<94			
32					6.5	
33					6.5	
34					7.0	
35					7.8	
36					7.5	
37					7.5	
38					7.0	
39					7.0	
40						

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*Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

PROJECT FILE

COMMENTS DRILL SITE W-10A

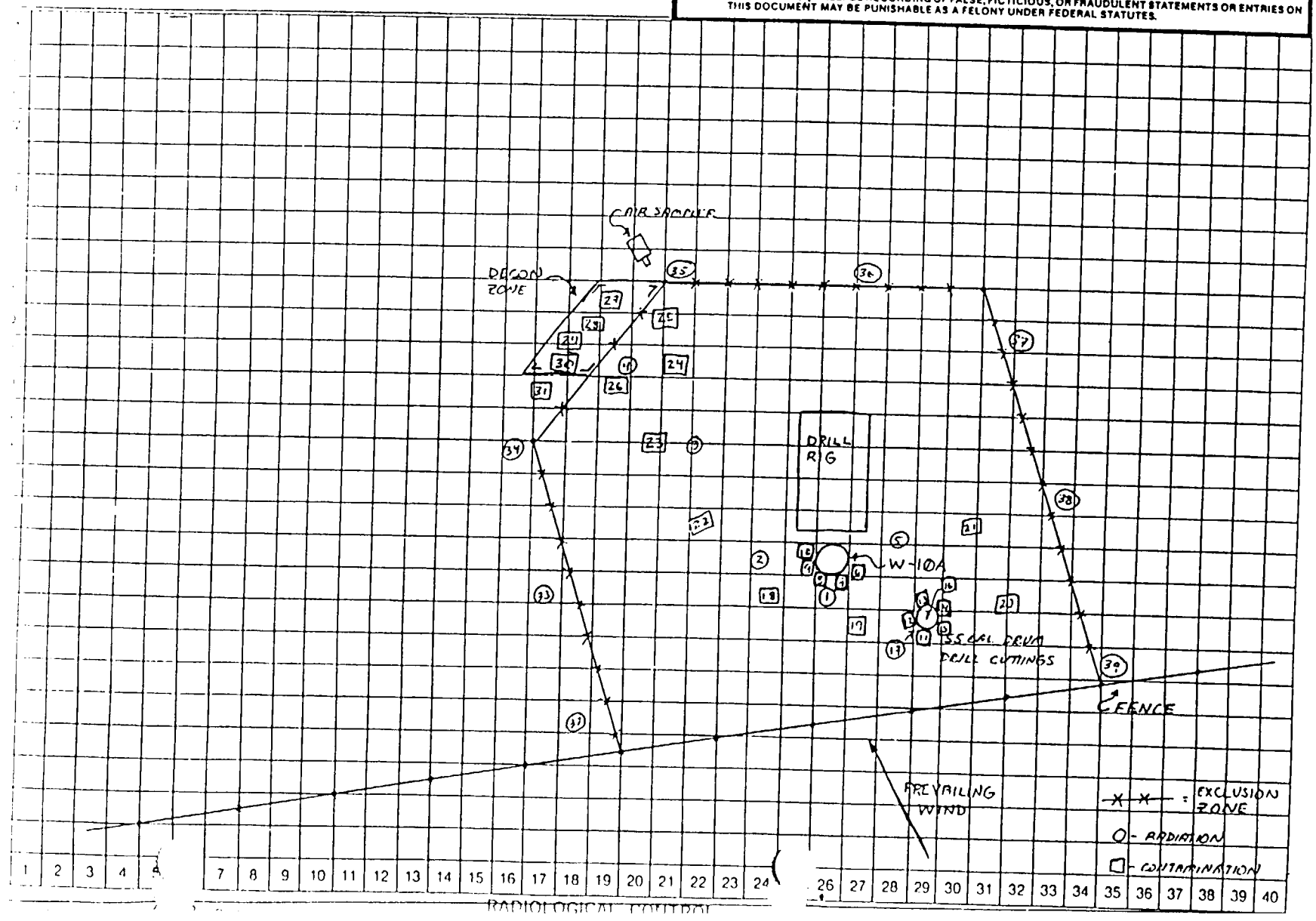
ACTIVITY/LOCATION GSA-WATERTOWN (46019) WATERTOWN, MA

SURVEYOR S. JOHNSON

PAGE 2 OF 2

DATE 19 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-20-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 20 JUN 90

Sample Location W-10A Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = (net cpm)x(C.F.) x (4.505 x 10^{-7} uCi/dpm) X Fa / (Sample volume) x (10^3 ml/l) or (2.83 x 10^4 ml/ft3)

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		6.5 m^3

β^- \ γ Counting Inst./Serial# ESP-1/1116 C.F. 5.0 MDA 2.1×10^{-12}

COUNTED 1400 6-23-90

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
712	20	36	33	3	$< 2.1 \times 10^{-12}$	

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

COUNTED 1435 6-23-90

Sample Location WC-5A Technician S. JOHNSON

Air Sampler/# RADECO/46019 Filter Used GELMAN A/E

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		7.0 m^3

β^-/γ Counting Inst./Serial# ESP-1/1116 C.F. 5.0 MDA 1.96×10^{-12}

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
679	~~30~~ 20	34	33	1	$< 1.96 \times 10^{-12}$	

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 20 JUN 90 | TIME START: 0930 | TIME COMPL: 1030 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA-WATERTOWN 46017 WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-20-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE W-10A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2467 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.76	—
MDA	dpm	138 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	7.2 μR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE-TAG NO: ALPHA — ; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 23 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<138			LOCATION SHOWN ON
2			<138			MAP 6-20-01.
3			<138			
4			<138			
5			<138			
6			<138			
7			<138			
8			<138			
9			<138			
10			<138			
11			<138			
12			<138			
13			<138			
14			<138			
15			<138			
16			<138			
17			<138			
18			<138			LOCATION SHOWN ON
19			<138			MAP 6-20-01.
20			<138			
21			<138			
22			<138			
23			<138			
24			<138			
25			<138			
26			<138			
27			<138			
28			<138			
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33			<138			
34			<138			
35			<138			
36			<138			
37			<138			
38			<138			
39			<138			
40			<138			

RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES

CHEM-NUCLEAR SYSTEMS INC.

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILES

PROJECT: PRIVATE SITE W-10A

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 6 20-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 20 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<138		LOCATION SHOWN ON
42					6.8	MAP 6-20-01
43					7.5	
44					7.8	
45					7.2	
46					7.0	
47					7.0	
48					7.3	
49					7.2	
50					7.5	
51					7.5	
52					6.8	
53					7.8	
54					7.6	

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION

ND - Not Detectable

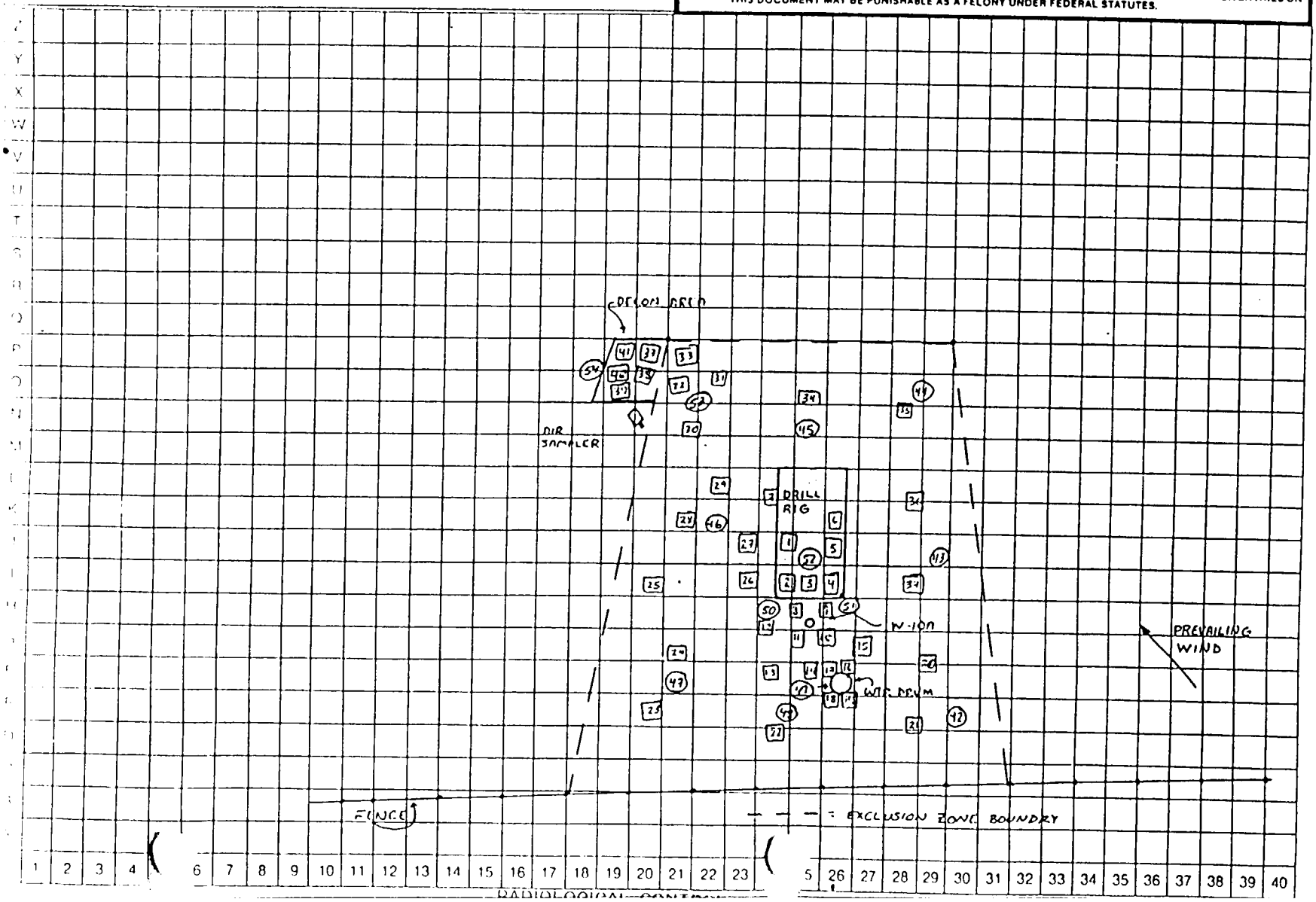
RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

ID: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA	PAGE 3 3	
COMMENTS: DRILL SITE W-10A	SURVEYOR: S. JOHNSON	DATE: 20 JUN 90	

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 20 JUN 90 | TIME START: 1300 | TIME COMPL: ~~1800~~ 1700 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-20-02

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: DRILL SITE WC-5A

PERMISSIBLE LEVELS: — dpm/100 cm ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2467 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 1.76 / 4.6711	—
MDA	dpm	138 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	7.2 μR/HR ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116	
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803	

RADCON REVIEW: [signature] DATE: 23 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1		2		<138		LOCATION SHOWN ON
2				<138		MAP ~~WC-5~~ 6-20-02
3				<138		
4				<138		
5				<138		
6				<138		
7				<138		
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10				<138		
11				<138		
12				<138		
13				<138		
14				<138		
15				<138		
16				<138		
17				<138		
18				<138		LOCATION SHOWN ON
19				<138		MAP 6-20-02
20				<138		
21				<138		
22				<138		
23				<138		
24		SV	5	<138		
25				<138		
26				<138		
27				<138		
28				<138		
29				<138		
30				<138		
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35				<138		
36				<138		
37				<138		
38				<138		
39				<138		
40				<138		

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS, INC.

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

SUBJECT: DRILL SITE WG-5A

ACTIVITY/LOCATION: GSA-WATERTOWN/WATERTOWN, MA

MAP ID: 6-20-02

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 20 JUN 70

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
41				<138		LOCATION SHOWN ON MAP
42				<138		6-20-02
43				<138		
44					7.0	
45					7.3	
46					7.2	
47					7.8	
48					6.5	
49					6.8	
50					6.5	
51					6.2	
52					6.5	
53					6.8	
54					6.6	
55					6.2	
56					6.8	
57					7.2	
58					7.5	

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV ___ dpm/PROBE	BETA-GAMMA EQUIV ___ dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTRO

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE WC 5A

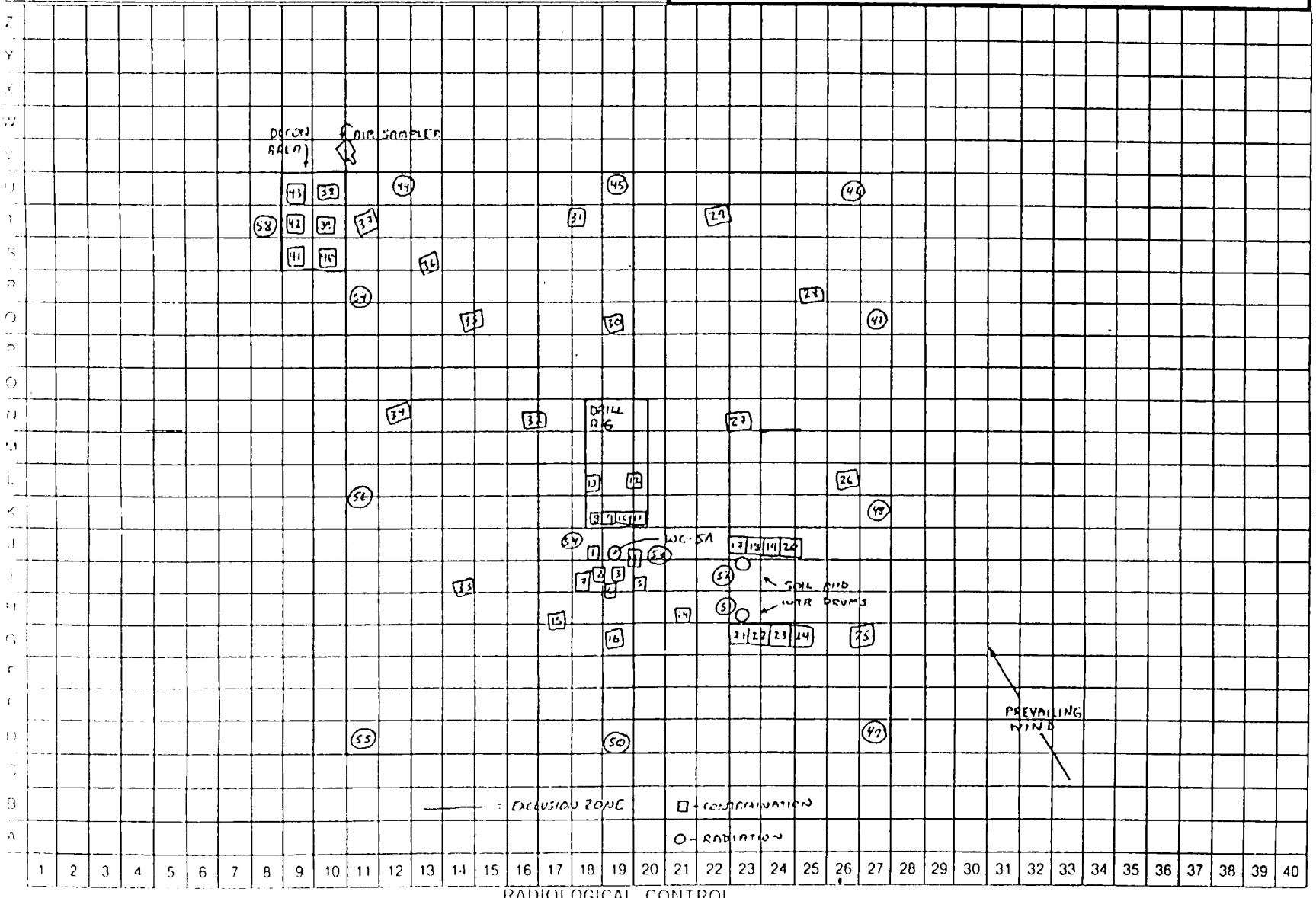
ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 3 3

DATE 20 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-21-01(A

Project Name/No. GSA-WATERTOWN/46019 Date 21 JUN 90

Sample Location SITE WC-5A, 3A, B-12 Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3 \text{ ml/l) or (2.83 x } 10^4 \text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		17 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 5.0 MDA 8.1×10^{-13}

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
744		20		37			33		4	$< 8.1 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 21 JUN 90 | TIME START: 0830 | TIME COMPL: 0915 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-21-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE WC-5A

PERMISSIBLE LEVELS: — dpm/100 cm ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr
INSTRUMENT RESPONSE	cpm	2596 cpm	— mR/hr
EFFICIENCY/CORRECTION FACTOR		0.22 / 4.55	—
MDA	dpm	136 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.3 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116	
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803	

RADCON REVIEW: [signature] DATE: 23 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm²	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<136			LOCATION SHOWN ON
2			<136			MAP 6-21-01
3			<136			
4			<136			
5			<136			
6			<136			
7			<136			
8			<136			
9			<136			
10			<136			
11			<136			
12			<136			
13			<136			
14			<136			
15			<136			
16			<136			
17			<136			
18			<136		~~<13~~ 11	LOCATION SHOWN ON
19			<136			MAP 6-21-01
20			<136			
21			<136			
22			<136			
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24			<136			
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39			<136			
40			<136			

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CHEM NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

PROJECT: DRILL SITE WC-SA

ACTIVITY/LOCATION: GSA - WATERTOWN, WATERTOWN, MA

MAP ID: 6-21-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 21 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<136		LOCATIONS SHOWN ON MAP
42				<136		6-21-01

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC.

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE WC-5A

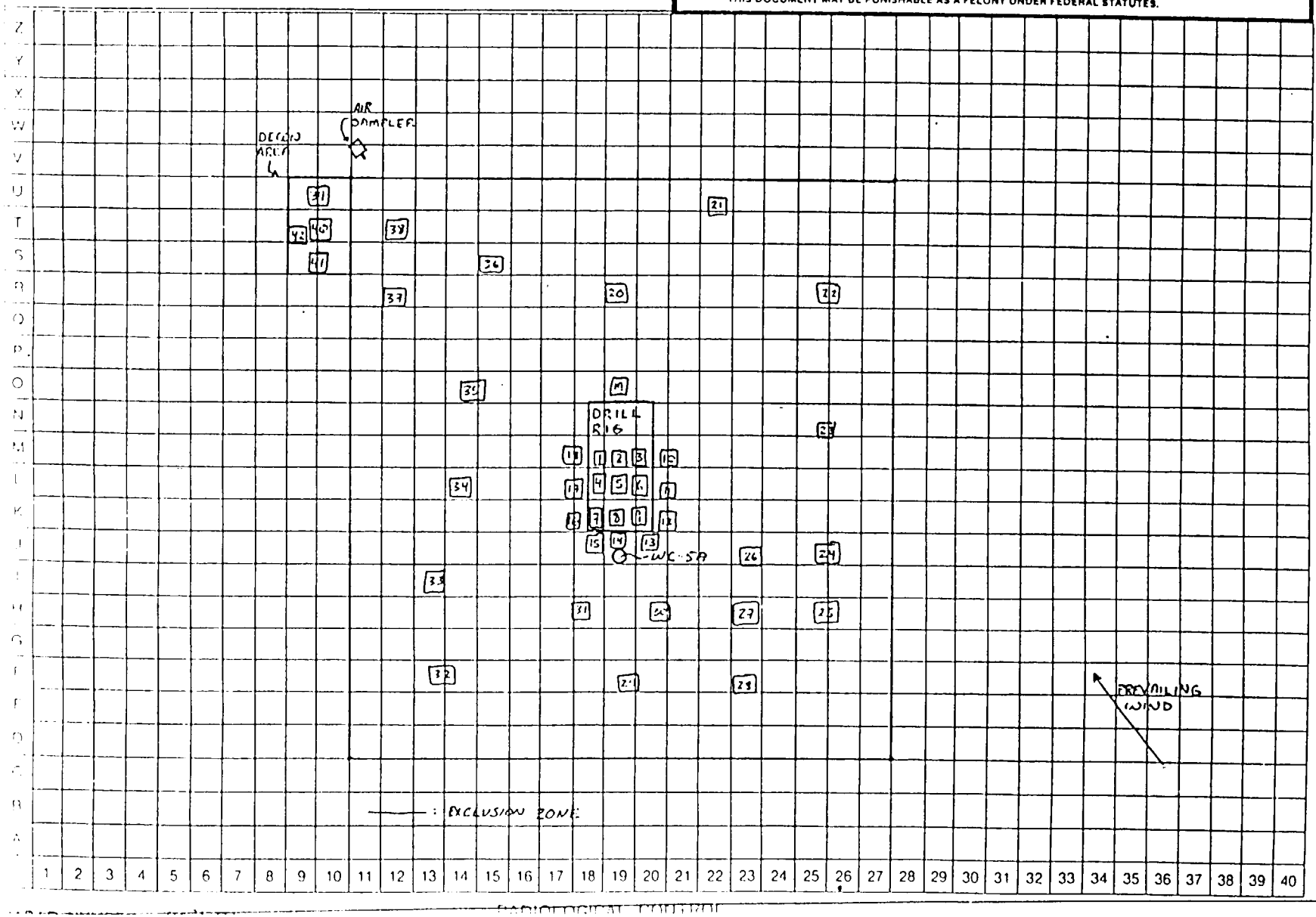
ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE: 3 3

DATE: 21 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILES

DATE: 21 JUN 90 | TIME START: 1015 ~~0930~~ | TIME COMPL: 1745 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-21-02

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITES WC-3A, B-12

PERMISSIBLE LEVELS: ____ dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-233	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2576 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	136 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.8 μR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA —; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON —; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE 23 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ____ ☐ SPECIAL ____ ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm²	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<136			LOCATION SHOWN ON MAP 6-21-02
2			<136			
3			<136			
4			<136			
5			<136			
6			<136			
7			<136			
8			<136			
9			<136			
10			<136			
11			<136			
12			<136			
13			<136			
14			<136			
15			<136			
16			<136			
17			<136			
18			<136			LOCATION SHOWN ON MAP 6-21-02
19			<136			
20			<136			
21			<136			
22			<136			
23			<136			
24			<136			
25			<136			
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27			<136			
28			<136			
29			<136			
30			<136			
31			<136			
32			<136			
33			<136			
34			<136			
35			<136			
36			4436	8.0	≈6" BELOW	(0-2 FT SPLIT SPOON) SURFACE
37			<136			
38			<136			
39			<136			
40			<136	7.8	(5-7 FT SPLIT-	SPOON)

THE KNOWING & WILLFUL CODING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISABLE AS A FELONY UNDER FEDERAL STATUTES

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

DRILL SITES WC-3A, B-12

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 6-21-02

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 21 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
41				<136		LOCATION SHOWN ON
42				<136		MAP 6-21-02
43				<136		
44				<136		
45				<136		
46				<136		
47				<136		
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49				<136		
50				<136		
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58				<136		
59				<136		
60				<136		
61				<136		
62				<136		
63				<136		
64				<136		
65				<136		
66				<136		

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
67				<136		LOCATION SHOWN ON
68				<136		MAP 6-21-02
69				<136		
70				<136		
71				<136		
72				<136		
73				<136		
74				<136		
75				<136		
76				<136		
77				<136		
78				<136		
79				<136		
80					7.5	
81					7.8	
82					7.8	
83					7.0	
84				<136		
85				<136		
86				<136		
87				<136		
88				<136		
89				<136		
90				<136		
91				<136		

ND - Not Detectable

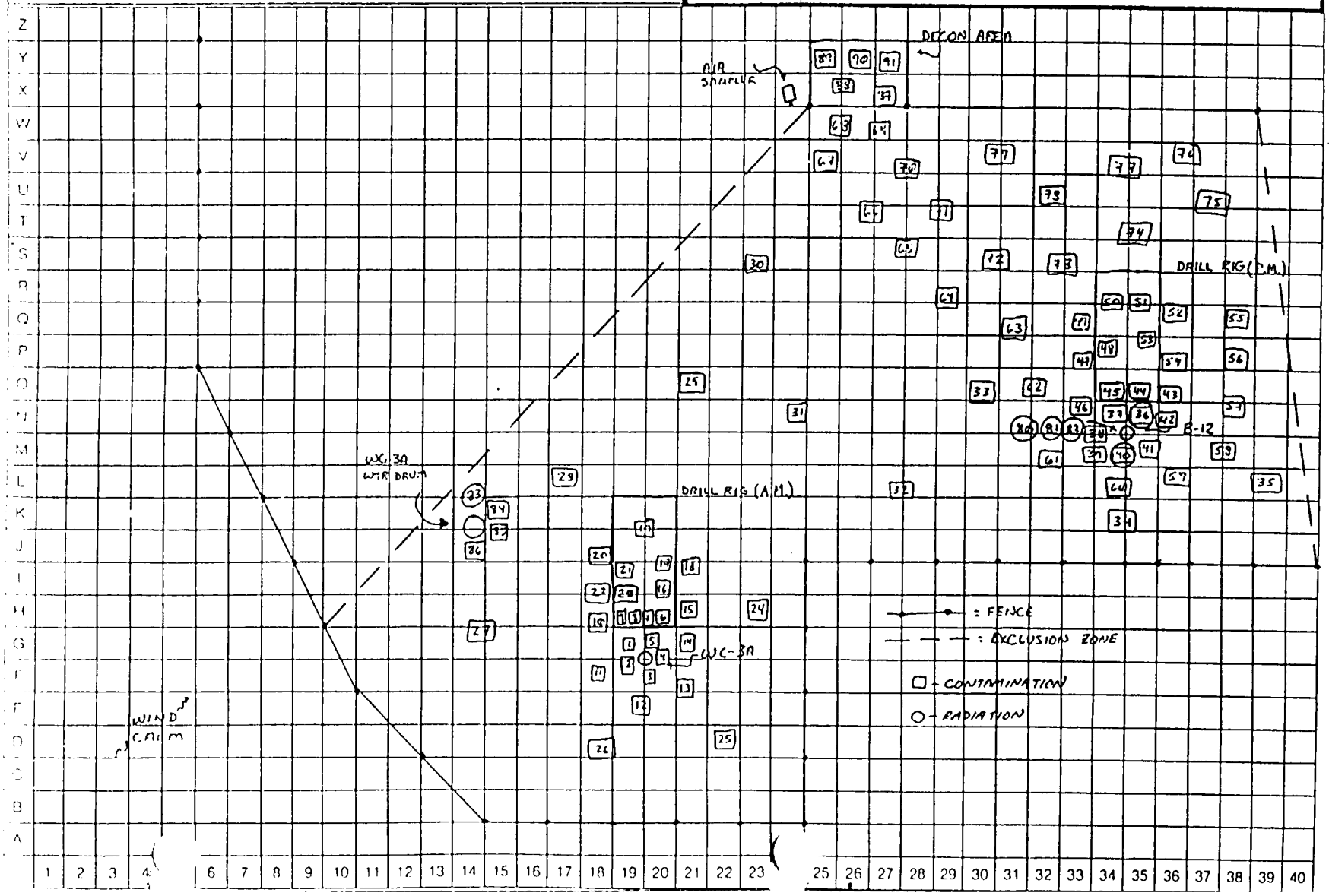
RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN	PAGE 3 3	
COMMENTS: DRILL SITES WC-3A, B-12	SURVEYOR: S. JOHNSON	DATE: 21 JUNE 90	

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-22-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 22 JUN 90

Sample Location DRILL SITE B-12, B-13, WC-2A Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/C

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		12.5 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 5.0 MDA 1.14×10^{-12}

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
COUNTED @ 1800 6-23-90										
750		20		38			33		5	$< 1.14 \times 10^{-12}$
							3			

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 22 JUN 90 | TIME START: 0830 ~~1015~~ | TIME COMP: 1700 ~~1745~~ | PAGE 1 OF 5

ACTIVITY LOCATION: GSA-WATERTOWN (YKOIN), WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-22-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: DRILL SITE B-12, B-13, WC-2A

PERMISSIBLE LEVELS	CSCA AREA CONTROL LEVELS	
— dpm/100 cm² ALPHA	N/ dpm/100 cm² ALPHA	☐ OTHER (SEE COMMENTS)
<1000 dpm/100 cm² BETA-GAMMA	/A dpm/100 cm² BETA-GAMMA	■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2334 cpm	— mR/hr
EFFICIENCY/CORRECTION FACTOR		0.2 / 5.0	—
MDA	dpm	155 dpm	SAT ■ UNSAT. ☐
BACKGROUND	cpm	36 cpm	6.5 μR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE TAG NO	ALPHA	BETA-GAMMA
	—	ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON	BETA-GAMMA
	—	ESP-2 #803

RADCON REVIEW: [signature] DATE: 23 JUN 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE PROBE NO	ALPHA EQUIV — dpm PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			30975 (1)		11.2	LOCATION SHOWN ON
2			<155		N/A	MAP 6-22-01 ~~6-21-02~~
3			<155			
4			<155			
5			<155			
6			<155			
7			13,000		7.5	(5-7 FT SPLITSPOON)
8			<155		N/A	
9			<155			
10			<155			
11			<155			
12			1625		7.5	(10-12 FT SPLITSPOON)
13			<155		N/A	
14			<155			
15			<155			
16			<155			
17			<155			

SWIPE PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
18			<155		N/A	LOCATION SHOWN ON
19			<155			MAP 6-22-01 ~~6-21-02~~
20			<155			
21			<155			
22			<155			
23			<155			
24			<155			
25			<155			
26			<155			
27			<155			
28			<155			
29			<155			
30			<155			
31			<155			
32			<155			
33			<155			
34			<155			
35			<155			
36			<155			
37			<155			
38			<155			
39			<155			
40			<155			

THE KNOWING & WILL[illegible] CORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE P[illegible] OLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS, INC.

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE
COMMENTS: DRILL SITE B-12, B-13, WC-20

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA
MAP ID: 6-22-01
PAGE 2 OF 5
SURVEYOR: S. JOHNSON
DATE: 22 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
41				<155	N/A	LOCATION SHOWN ON
42				<155		MAP 6-22-01
43				<155		
44				<155		
45				<155		
46				<155		
47				<155		
48				<155		
49				<155		
50				<155		
51				<155		
52				<155		
53				<155		
54				<155		
55				<155		
56				<155		
57				<155		
58				<155		
59				<155		
60				<155		
61				<155		
62				<155		
63				<155		
64				<155		
65				<155		
66				<155		

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
67				<155	N/A	LOCATION SHOWN ON
68				<155		MAP 6-22-01
69				<155		
70				<155		
71				<155		
72				<155		
73				<155		
74				<155		
75				<165		
76				<155		
77				<155		
78				<155		
79				<155		
80				<155		
81				<155		
82				<155		
83				<155		
84				<155		
85				<155		
86				<155		
87				<155		
88				<155		
89				<155		
90				<155		
91				<155		
92				<156		

ND = Not Detectable

CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 6-22-01

COMMENTS: DRILL SITE B-12, B-13, WC-2A

SURVEYOR: S. JOHNSON

DATE: 22 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
93				<155	N/A	MAP 6-22-01
94				<155		
95				<155		
96				<155		
97				<155		
98				<155		
99				<155		
100				<155		
101				<155		
102				<155		
103				<155		
104				<155		
105				<155		
106				<155		
107				<155		
108				<155		
109				<155		
110				<155		
111				<155		
112				<155		
113				<155		
114				<155		
115				<155		
116				<155		
117				<155		
118				<155		

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
119				<155	N/A	MAP 6-22-01
120				<155		
121				<155		
122				<155		
123				<155		
124				<155		
125				<155		
126				<155		
127				<155		
128				<155		
129				<155		
130				<155		
131				<155		
132				<155		
133				<155		
134				<155		
135				<155		
136				<155		
137				<155		
138				<155		
139				<155		
140				<155		
141				<155		
142				<155		
143				<155		
144				<155		

*ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC.

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: DRILL SITE B-12, B-13, WC-2A

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 6-22-01

PAGE 4 OF 5

SURVEYOR: S. JOHNSON

DATE: 22 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV V-233 dpm/PROBE	BETA-GAMMA EQUIV V-233 dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
145				<155	N/A	MAP 6-22-01
146				<155		
147				<155		
148				<155		
149				<155		
150				<155		

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV ___ dpm/PROBE	BETA-GAMMA EQUIV ___ dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION

CHEM-NUCLEAR SYSTEMS, INC

ND - Not Detectable

RADIOLOGICAL CONTROL

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE B-12, B-13, WC-2A

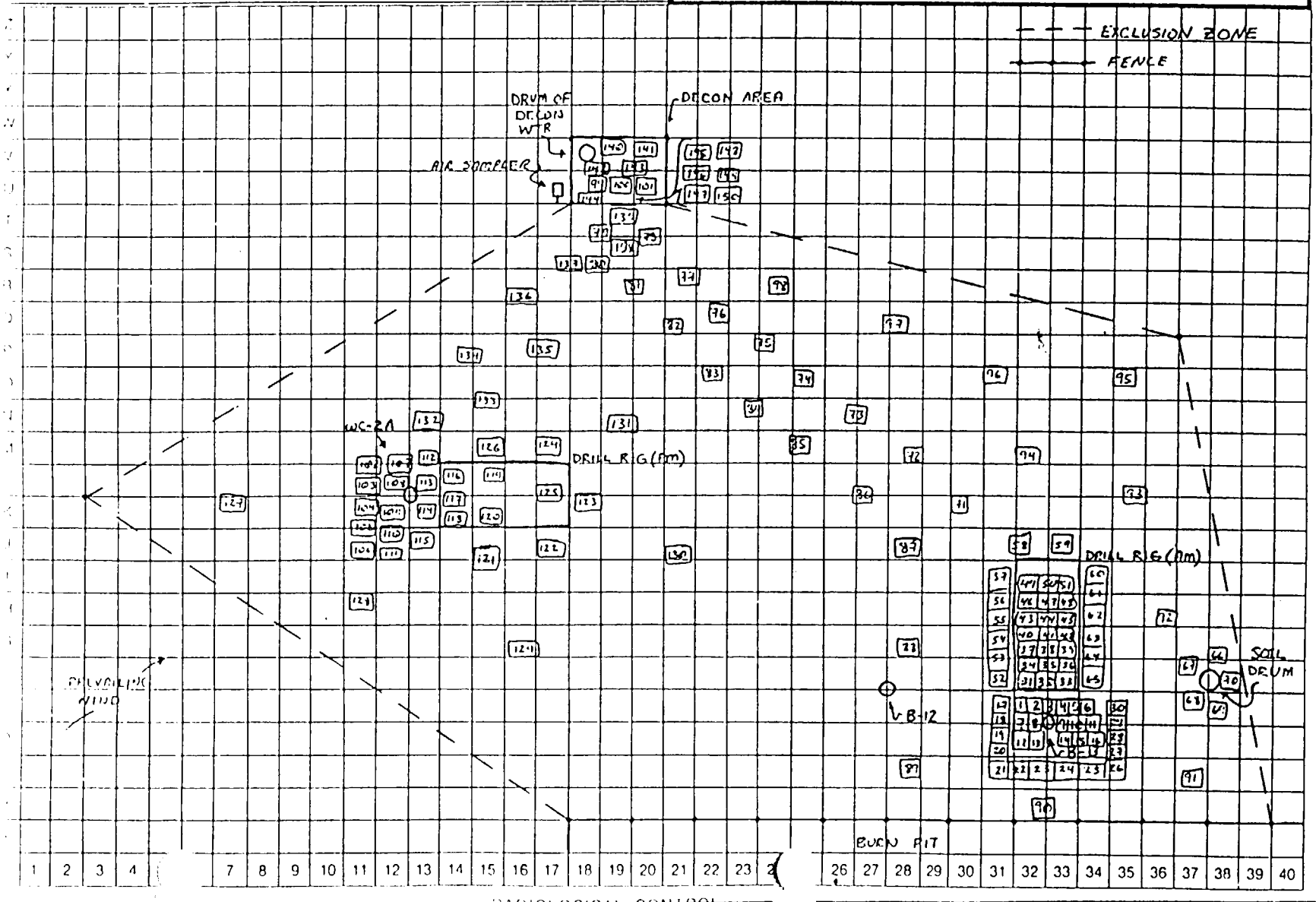
ACTIVITY/LOCATION: USA-WATERTOWN WATERTOWN, MA

PAGE 5 ~~3~~/11 5

SURVEYOR: S. JOHNSON

DATE: 22 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS, INC

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

23 JUN 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

24 JUN 90

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-25-01(A)

Project Name/No. GSA-WATERTOWN / 46019 Date 25 JUN 90

Sample Location DRILL SITE WC-2A, B-14, B-17 Technician J. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		15 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.55 MDA 8.46×10^{-13}

COUNTED 28 JUN 90 1830

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
694		20		35			34		1	~~<1.57~~ $<8.46 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 25 JUN 90 | TIME START: 0810 | TIME COMPL: 1700 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON

PHONE: —

MAP ID: 6-25-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE WC-2A, B-14, B-17

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2506 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.8 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<143		N/A	LOCATION SHOWN ON
2			<143			MAP 6-25-01
3			<143			
4			<143			
5			<143			
6			<143			
7			<143			
8			<143			
9			<143			
10			<143			
11			<143			
12			<143			
13			<143			
14			<143			
15			<143			
16			<143			
17			<143			
18			<143		N/A	LOCATION SHOWN ON
19			<143			MAP 6-25-01
20			<143			
21			<143			
22			<143			
23			<143			
24			<143			
25			<143			
26			<143			
27			<143			
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30			<143			
31			<143			
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33			<143			
34			<143			
35			<143			
36			<143			
37			<143			
38			<143			
39			<143			
40			<143			

THE KNOWING A[illegible] RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE [illegible] HABLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: DRILL SITES B-14, B-15, WC-2A

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 6-25-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 25 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV — dpm/ PROBE	ALPHA EQUIV — dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143	N/A	MAP 6-25-01
42				<143		
43				<143		
44				<143		
45				<143		
46				<143		
47				<143		
48				<143		
49				<143		
50				<143		
51				<143		
52				<143		
53				<143		
54				<143		
55				<143		
56				<143		
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58				<143		
59				<143		
60				<143		
61				<143		
62				<143		
63				<143		
64				<143		
65				<143		
66				<143		

SWIPE/ PROBE NO	ALPHA EQUIV — dpm/ PROBE	ALPHA EQUIV — dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
67				<143	N/A	MAP 6-25-01
68				<143		
69				<143		
70				<143		
71				<143		
72				<143		
73				<143		
74				<143		
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80				<143		
81				<143		
82				<143		
83				<143		
84				<143		
85				<143		
86				<143		
87				<143		
88				<143		
89				<143		
90				<143		

ND - Not Detectable

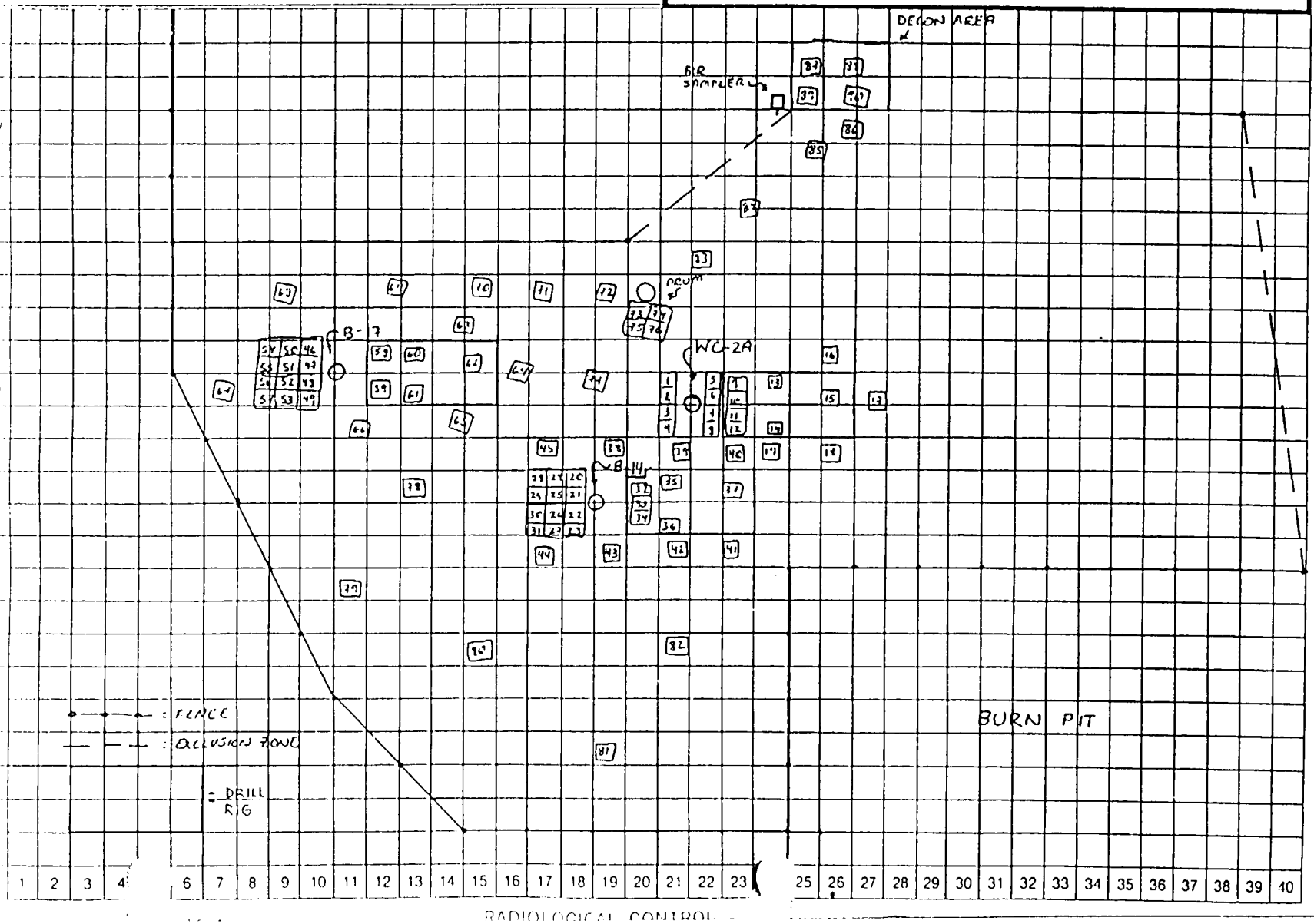
RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA	PAGE 3 3
COMMENTS: DRILL SITE WC-2A, B-14, B-17	SURVEYOR: S. JOHNSON	DATE: 25 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-26-01(A)

Project Name/No. GSA-WATERTOWN / 46019 Date 26 JUN 90

Sample Location DRILL SITE B-3,4,5,18 Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = (net cpm)x(C.F.) x (4.505 x 10^{-7} uCi/dpm) X Fa / (Sample volume) x (10^3 ml/l) or (2.83 x 10^4 ml/ft3)

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		15.75

β^- \ γ Counting Inst./Serial# CSP-1 / 1116 C.F. 1.55 MDA 8.05×10^{-13}

COUNTED 28 JUN 90 1902

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
737	20	37		34	3	< 8.05×10^{-13}

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 26 JUN 90 | TIME START: 0745 | TIME COMPL: 1730 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-26-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE B-3, B-4, B-18, B-5

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; 1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr
INSTRUMENT RESPONSE	cpm	2408 cpm	— mR/hr
EFFICIENCY/CORRECTION FACTOR		0.2 / 5.0	—
MDA	dpm	145 dpm	SAT ■ UNSAT ☐
BACKGROUND	cpm	32 cpm	6.5 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW [signature] DATE 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				<145	N/A	LOCATION SHOWN ON
2				<145		MAP 6-26-01
3				<145		
4				<145		
5				<145		
6				<145		
7				<145		
8				<145		
9				<145		
10				<145		
11				<145		
12				<145		
13				<145		
14				<145		
15				<145		
16				<145		
17				<145		
18				<145	N/A	MAP 6-26-01
19				<145		
20				<145		
21				<145		
22				<145		
23				<145		
24				<145		
25				<145		
26				<145		
27				<145		
28				<145		
29				<145		
30				<145		
31				<145		
32				<145		
33				<145		
34				<145		
35				<145		
36				<145		
37				<145		
38				<145		
39				<145		
40				<145		

THE KNOWING & WILLFUL DOING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNI AS A FELONY UNDER FEDERAL STATUTES.

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA	MAP ID: 6-26-01	PAGE 2 OF 3
PROJECT: DRILL SITE B-1, B-4, B-18, B-5	SURVEYOR: S. JOHNSON		DATE: 26 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
41				<145	N/A	MAP 6-26-01
42				<145		
43				<145		
44				<145		
45				<145		
46				<145		
47				<145		
48				<145		
49				<145		
50				<145		
51		DECO		<145		
52				<145		
53				<145		
54				<145		
55				<145		
56				<145		
57				<145		
58				<145		
59				<145		
60				<145		
61				<145		
62				<145		
63				<145		
64				<145		
65				<145		
66				<145		

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
67				<145	N/A	MAP 6-26-01
68				<145		
69				<145		
70				<145		
71				<145		
72				<145		
73				<145		
74				<145		
75				<145		
		SWIPE				

(ND) Not Detectable

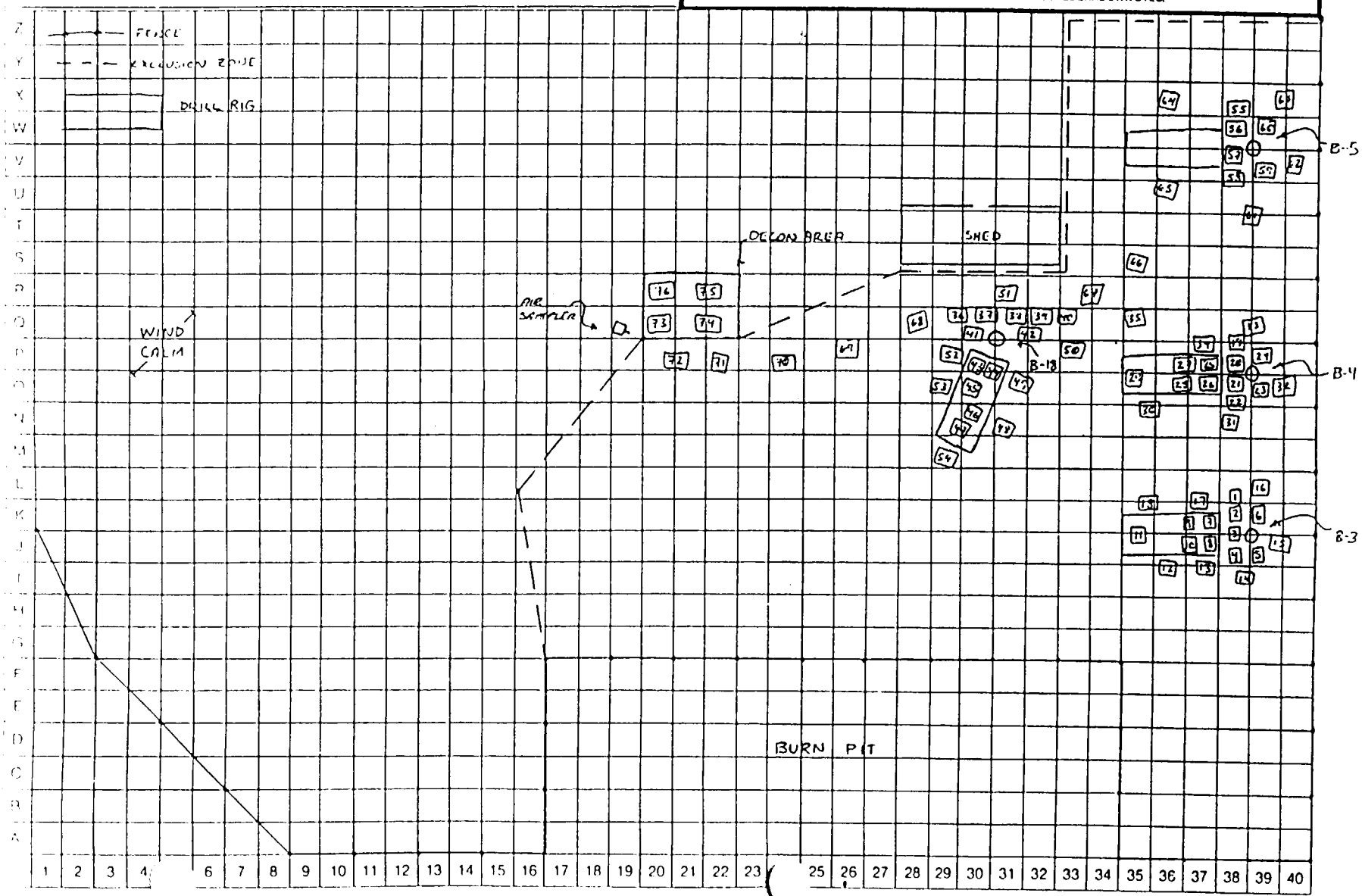
CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN MA	PAGE 3 3
COMMENTS: DRILL SITE B-3, B-4, B-13, B-5	SURVEYOR: S. JOHNSON	DATE: 26 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

RP I.D. NUMBER

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-27-α(A)

Project Name/No. GSA WATERTOWN / 46017 Date 27 JUN 90

Sample Location DRILL SITE Technician J. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x } 10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		13.8

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 #1116 C.F. 4.55 MDA 9.21×10^{-13}

COUNTED 28 JUN 90 1922

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
720		20		36			34		2	$< 9.21 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 27 JUN 90 | TIME START: 0800 | TIME COMPL: 1700 | PAGE 1 of 3

ACTIVITY/LOCATION: G.E. WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-27-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITES B-5, B-19, WC-6A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2317 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.2/5.0	—
MDA	dpm	145 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	6.5 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116	
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803	

RADCON REVIEW: [signature] DATE: 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<145			LOCATION SHOWN ON
2			<145		6.5	MAP 6-27-01
3			<145			
4			<145			
5			<145			
6			<145			
7			<145			
8			<145			
9			<145			
10			<145			
11			<145		6.5	
12			<145			
13			<145			
14			<145			
15			<145			
16			<145			
17			<145			
18			<145			MAP 6-27-01
19			<145			
20			<145			
21			<145			
22			<145			
23			<145			
24			<145			
25			<145			
26			<145			
27			<145			
28			<145		7.5	
29			<145			
30			<145			
31			<145		7.5	
32			<145			
33			<145			
34			<145			
35			<145			
36			<145			
37			<145			
38			<145			
39			<145			
40			<145			

FALSE STATEMENTS OR SUPPLIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: DRILL SITE B-5, B-19, WC-6A

ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

MAP ID: 6-27-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 27 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<145		MAP 6-27-01
42				<145		
43				<145		
44				<145		
45				<145		
46				<145		
47				<145		
48				<145		
49				<145		
50				<145		
51				<145	7.2	
52				<145		
53				<145		
54				<145		
55				<145		
56				<145	7.5	
57				<145		
58				<145		
59				<145		
60				<145		
61				<145		
62				<145		
63				<145		
64				<145		
65				<145		
66				<145		

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
67				<145		MAP 6-27-01
68				<145		
69				<145		
70				<145		
71				<145		
72				<145		
73				<145		
74				<145		
75				<145		
76				<145		
77				<145		
78				<145		
79				<145		
80				<145		
81				<145		
82				<145		
83				<145		
84				<145		
85				<145		
86				<145		
87				<145		
88				<145		
89				<145		

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE B-5, B-19, WC-6A

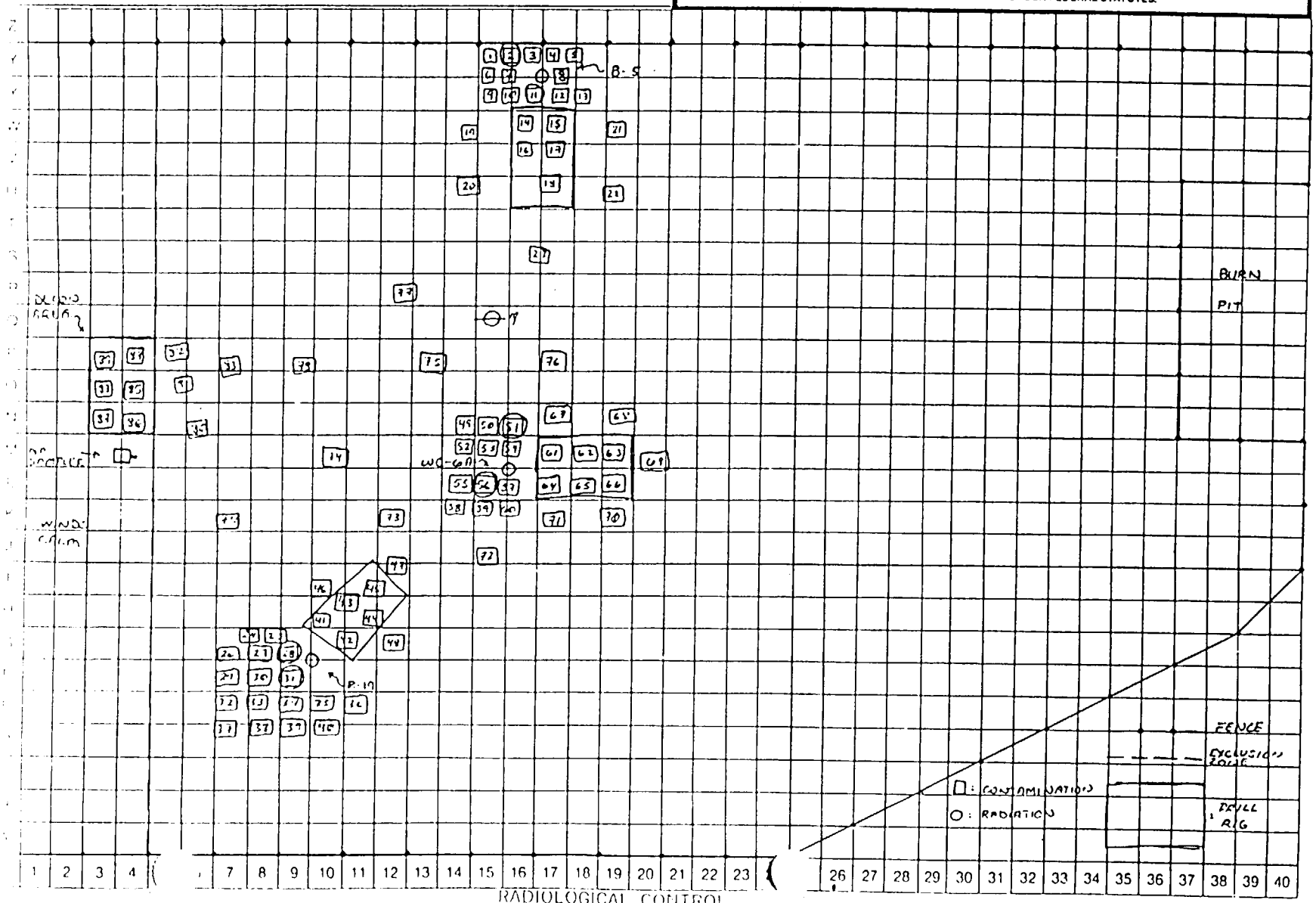
ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 3 3

DATE 27 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

ID NUMBER

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-28-01(A)

Project Name/No. GSA-WATERTOWN 46017 Date 28 JUN 90

Sample Location WORK AREA BOUNDRY Technician S. JOHNSON

Air Sampler Type/No. RADECO / 7055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
-	-	-		-		25 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.35 MDA 4.97×10^{-13}

COUNTED 7-2-90 1910

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
723	20	36	36	0		$<4.97 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷ Count Time	= cpm	cpm	- $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 28 JUN 90 | TIME START: 0700 | TIME COMPL: 1500 | PAGE 1 of 2

ACTIVITY/LOCATION: GSA-WATERTOWN
WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-28-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: GROUTING BOREHOLES

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr
INSTRUMENT RESPONSE	cpm	2442 cpm	— mR/hr
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	148 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	38 cpm	6.5 HR/HR ~~mRhr~~

CONTAMINATION SURVEY INSTRUMENT TYPE TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<148			SHOWN ON MAP
2			<148			6-28-01
3			<148			
4			<148			
5			<148			
6			<148			
7			<148			
8			<148			
9			<148			
10			<148			
11			<148			
12			<148			
13			<148			
14			<148			
15			<148			
16			<148			
17						

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV — dpm/PROBE	BETA-GAMMA EQUIV — cpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION
18						
19						
20						
21						
22						
23						
24						
25						
26						
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28						
29						
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THE KNOWING & WILLF[illegible] [illegible]ORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PU[illegible]LE AS A FELONY UNDER FEDERAL STATUTES.

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: GROUTING BOREHOLES

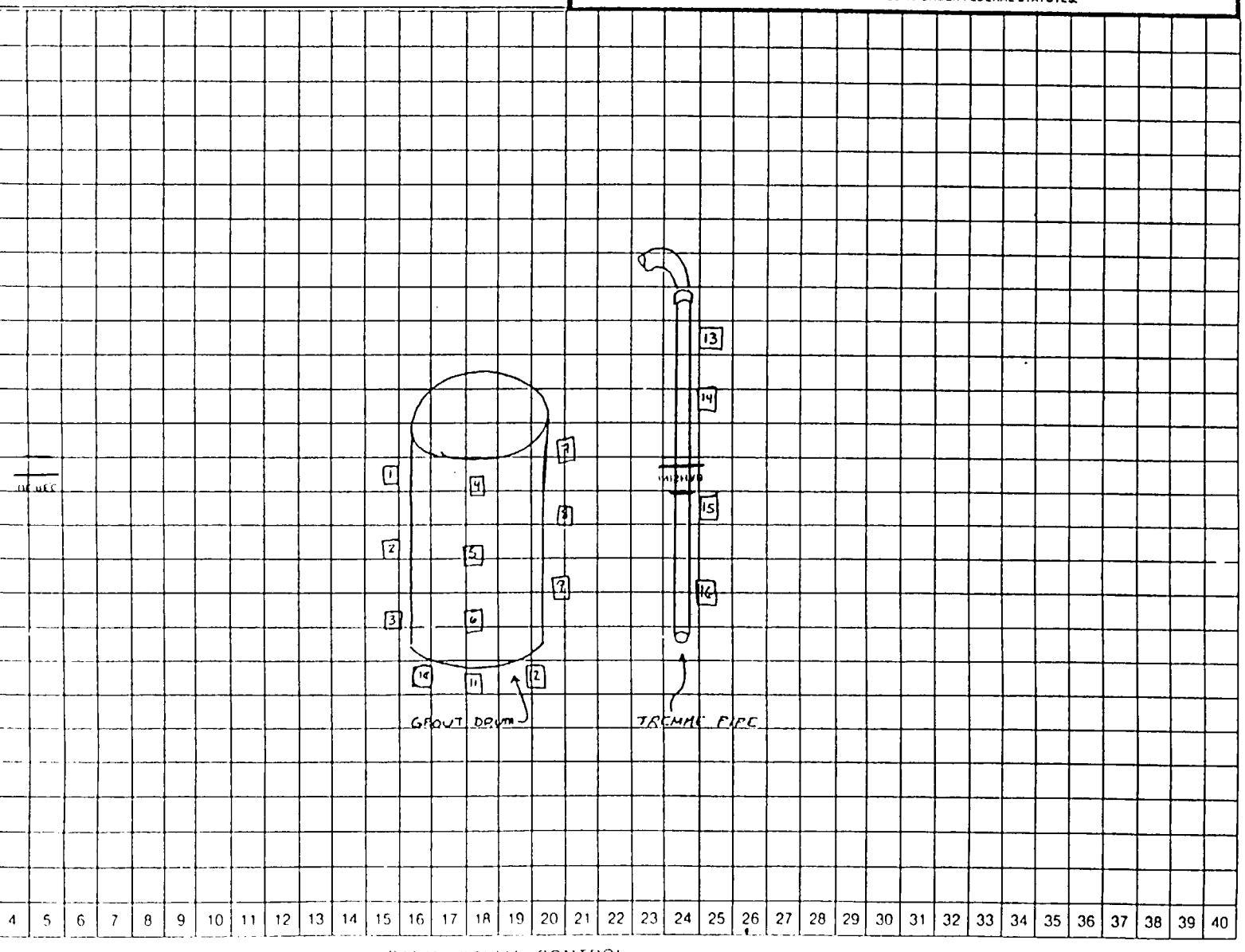
ACTIVITY/LOCATION: GSA-WATERTOWN/WATERTOWN, MA

PAGE: 2 2

SURVEYOR: S. JOHNSON

DATE: 28 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

AREA I.D. NUMBER 6-28-90

RADIOLOGICAL CONTROL

Scale - 1/4"

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 28 JUN 90 | TIME START: 1700 | TIME COMPL: 1715 | PAGE 1 / 2

ACTIVITY/LOCATION: GSR-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-28-02

DAILY ☐ WEEKLY ■ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ■ MONTHLY ☐ RADIATION SURVEY

COMMENTS: ESTABLISH RAM STOWAGE AREA

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-233	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2442 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.76	—
MDA	dpm	148 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	6.5 μR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WKLY RAM STOWAGE AREA

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-233 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<148		8.3	LOCATION SHOWN ON
2			<148		7.0	MAP 6-28-02
3			<148		6.8	
4			<148		7.0	
5			<148		7.0	
6			<148		7.3	
7			<148		6.8	
8			<148		6.5	
9			<148		7.0	
10			<148		7.2	
11			<148		6.9	
12			<148		6.8	
13			<148		7.0	
14			<148		7.0	
15			<148		7.5	
16			<148		7.0	
17			<148		6.8	
18			<148		7.0	MAP 6-28-02
19			<148		7.2	
20			<148		7.3	
21			<148		7.0	
22			<148		6.8	
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
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40						

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: ESTABLISH RAM STORAGE AREA

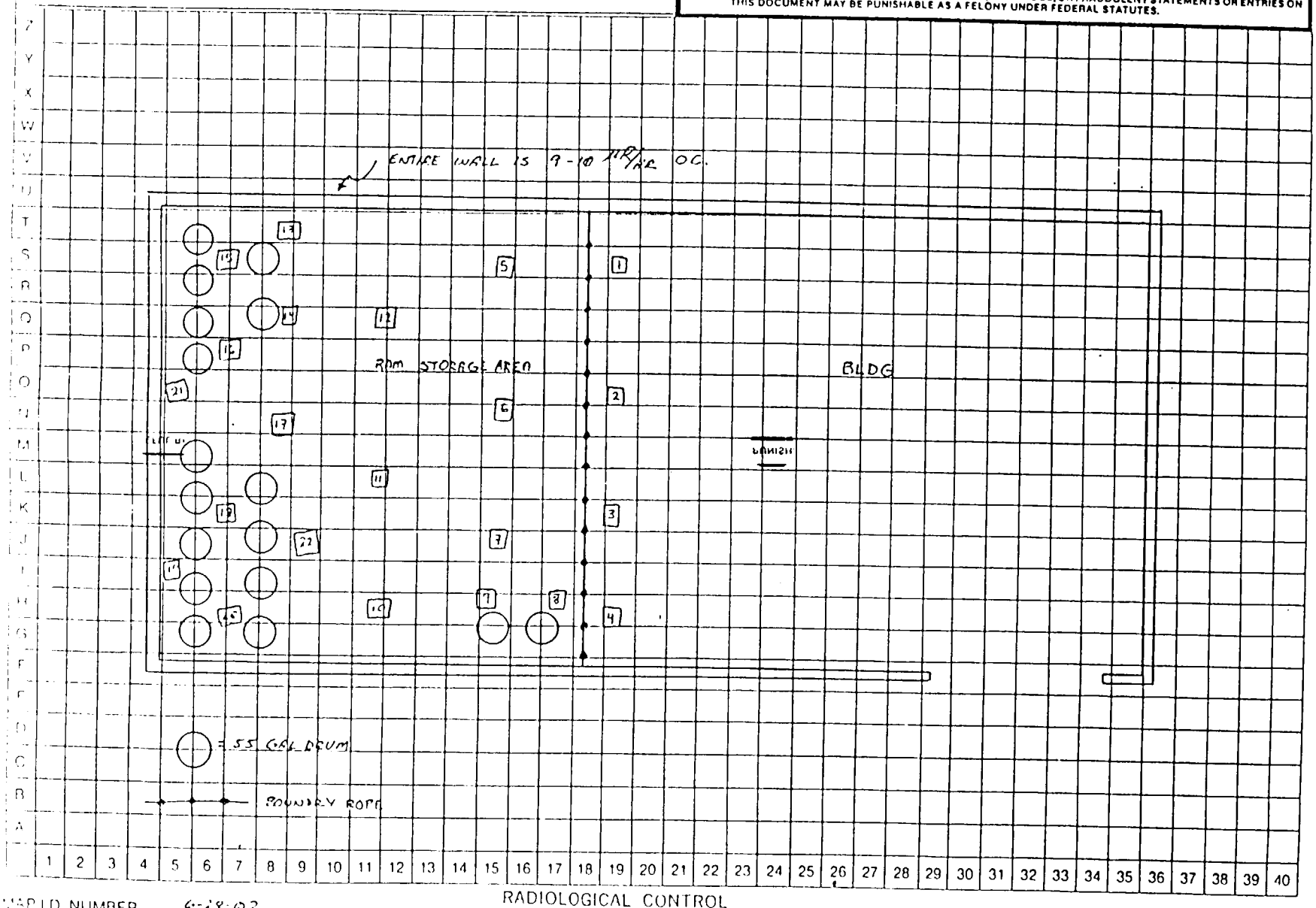
ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

PAGE 2 2

SURVEYOR: S. JOHNSON

DATE: 28 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



MAP ID NUMBER 6-28-02

RADIOLOGICAL CONTROL

Scale - 1/4" =

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 6-29-01(R)

Project Name/No. GSA-WATERTOWN/46019 Date 29 JUN 90

Sample Location DRILL SITE WC-4A, WC-1A Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		15.55 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1/1116 C.F. 4.35 MDA 3.00×10^{-13}

COUNTED 7-2-90 BRJC

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
684		20		34			36		0	$< 8.00 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 29 JUN 90 | TIME START: 0830 | TIME COMPL: 1630 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 6-29-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITES WC-4A, WC-1A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; 1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2435 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.76	—
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.5 mR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<143			LOCATION SHOWN ON MAP 6-29-01
2			<143			
3			<143			
4			<143			
5			<143			
6			<143			
7			<143			
8			<143			
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12			<143			
13			<143			
14			<143			
15			<143			
16			<143			
17			<143			
18			<143			MAP 6-29-01
19			<143			
20			<143			
21			<143			
22			<143			
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26			<143			
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34			<143			
35			<143			
36			<143			
37			<143			
38			<143			
39			<143			
40			<143			

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CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 6-29-01

PAGE 2 OF 3

COMMENTS: DRILL SITES LOC. 4A, 4C-1A

SURVEYOR: S. JOHNSON

DATE: 29 JUN 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143		MRP 6-29-01
42				<143		
43				<143		
44				<143		
45				<143		

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTRO

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN MA	PAGE 3 3	
COMMENTS: DRILL SITES WC-1A, WC-1A	SURVEYOR: S. JOHNSON	DATE: 29 JUN 90	

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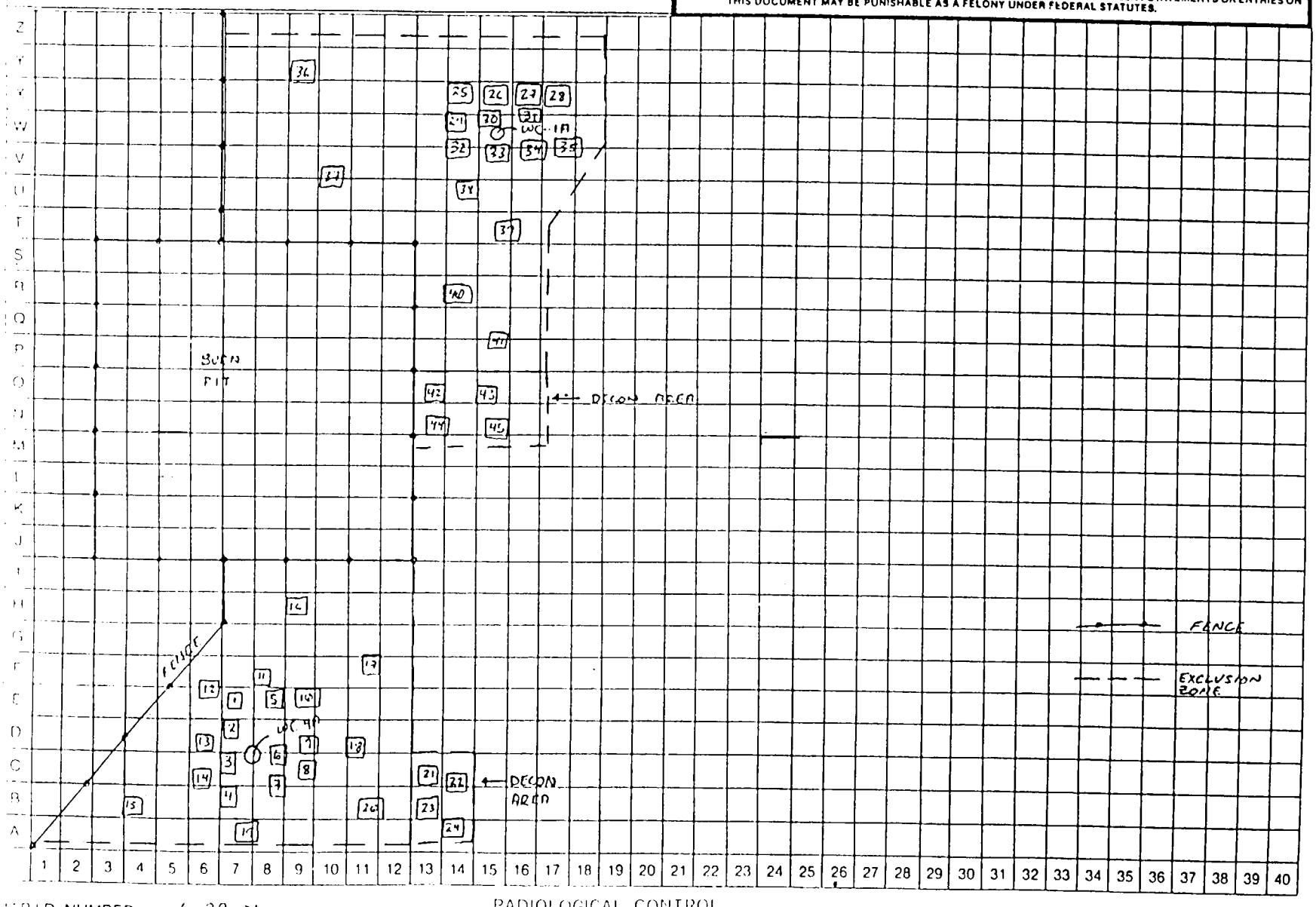

CHEM-NUCLEAR SYSTEMS, INC

GRID NUMBER 6-29-01

RADIOLOGICAL CONTROL

Scale - 1/4" =

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

30 JUN 90

CHEM NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

01 JUL 90

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-2-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 02 JUL 90

Sample Location DRILL SITE WC-1A/1B Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		8.42 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 1.69×10^{-12}

COUNTED 7-5-90 @ 1400

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)
769	20	38	39	0		$<1.69 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

CONTAMINATION AND RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 02 JUL 90 | TIME START: 0900 | TIME COMPL: 1715 | PAGE 1 OF 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 7-02-01

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE WG-1A/1D

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2533 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	141 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	37 cpm	0.5 MR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 # 1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 # 803

RADCON REVIEW: [signature] DATE: 02 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<141			LOCATION SHOWN ON MAP 7-02-01
2			<141			
3			<141			
4			<141			
5			<141			
6			<141			
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14			<141			
15			<141			
16			<141			
17			<141			
18			<141			MAP 7-02-01
19			<141			
20			<141			
21			<141			
22			<141			
23			<141			
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26			<141			
27			<141			
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29			<141			
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31			<141			
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35			<141			
36			<141			
37			<141			
38			<141			
39			<141			
40						

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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE WC-1A/1B

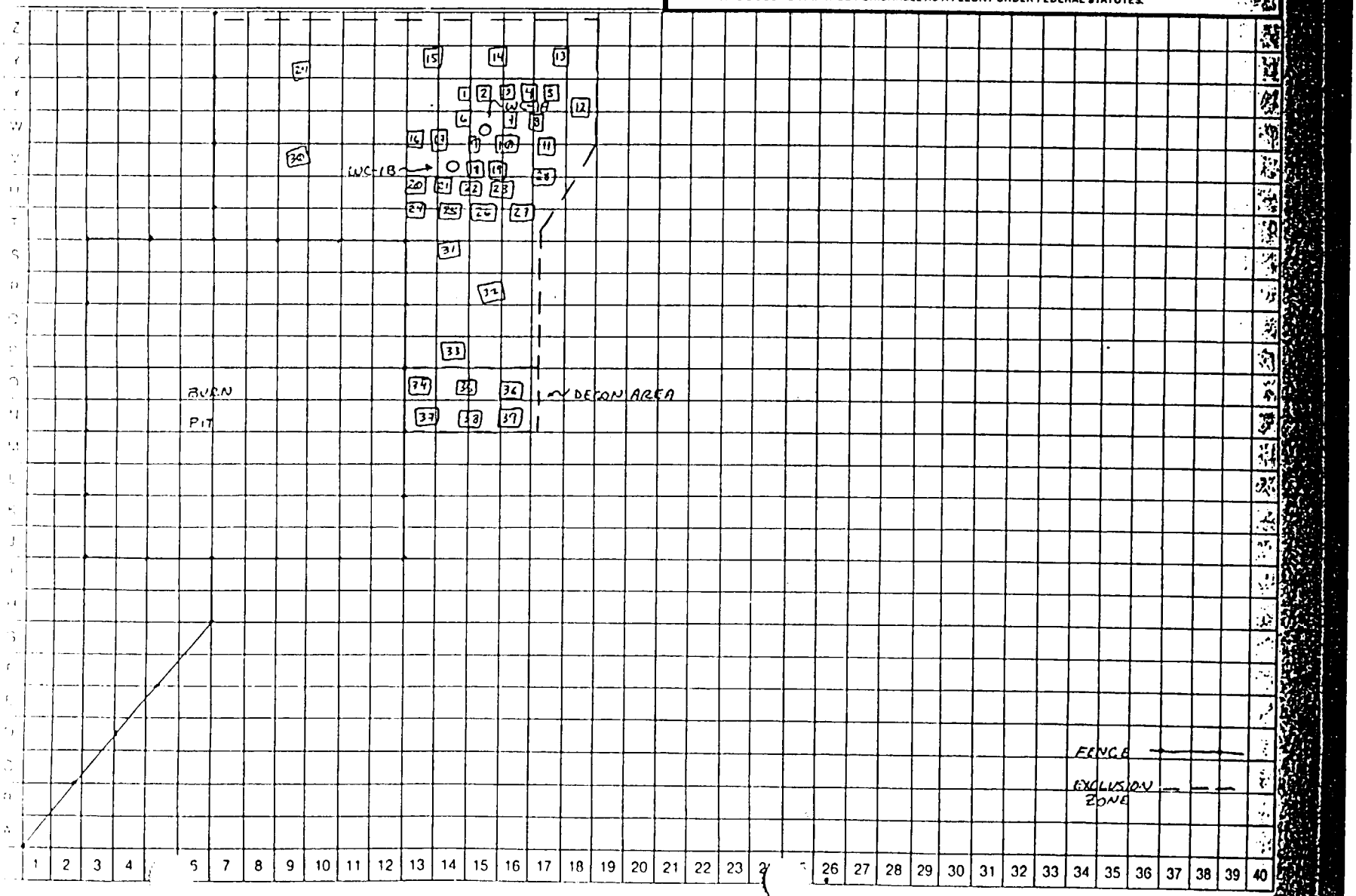
ACTIVITY/LOCATION: GSA-WATERTOWN WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 2 2

DATE: 02 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



GRID NUMBER 02-01

RADIOLOGICAL CONTROL

1/4" =

CHEM-NUCLEAR SYSTEMS, INC.

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-03-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 03 JUL 90

Sample Location DRILL SITE WC-18 Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{(\text{net cpm}) \times (\text{C.F.}) \times (4.505 \times 10^{-7}\ \text{uCi/dpm}) \times \text{Fa}}{(\text{Sample volume}) \times (10^3\ \text{ml/l}) \text{ or } (2.83 \times 10^4\ \text{ml/ft3})}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		15.1 m³

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.76 MDA 7.45×10^{-13}

COUNTED 7-5-90 1423

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)
744	20	37	37		0	$< 9.75 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 03 JUL 90 | TIME START: 0830 | TIME COMPL: 1715 | PAGE 1 / 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-03-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: DRILL SITE WC-13

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2491 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	145 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	39 cpm	6.5 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA — ; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: Scott A. [illegible] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<145			LOCATION SHOWN ON
2						MAP 7-03-01
3						
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SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
18			<145			MAP 7-03-01
19						
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

PROJECT FILE

DRILL SITE WC-1B

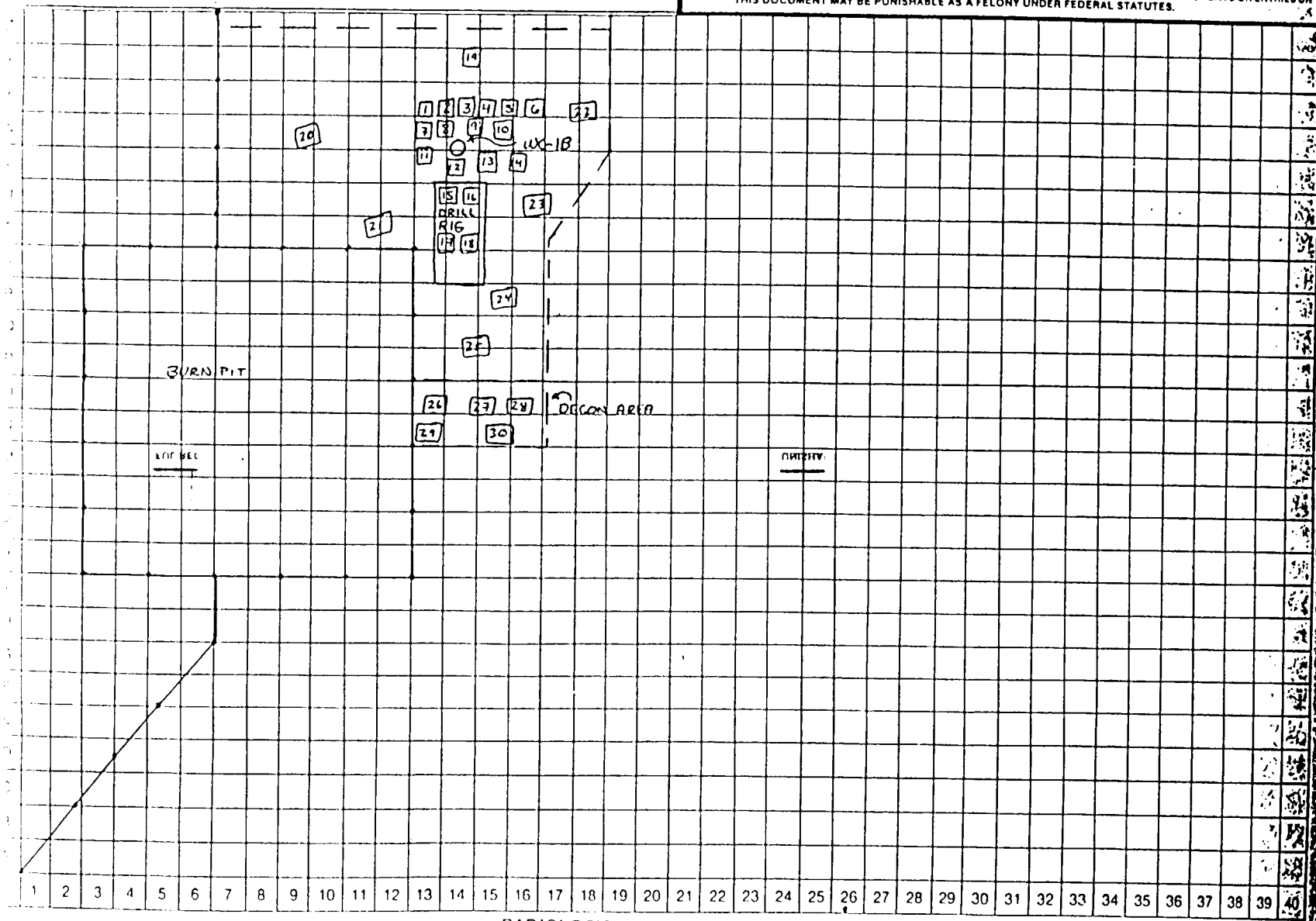
ACTIVITY/LOCATION GSA-WATERTOWN/WATERTOWN, MA

SURVEYOR S. JOHNSON

PAGE 2 2

DATE 03 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



GRID NUMBER 7-03-01

RADIOLOGICAL CONTROL

Scale - 1/4" = —

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-04-01(A

Project Name/No. GSA-WATERTOWN/46019 Date 04 JUL 90

Sample Location DRILL SITE WC-18, B-2 Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/C

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		12.4 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 1.15×10^{-12}

COUNTED 7-5-90 @ 1445

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
807		20		40			39		1	$< 1.15 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION / RADIATION SURVEY REPORT

TO	PROJECT FILE
DATE	04 JUL 90
TIME START	0815
TIME COMPL	1530
PAGE	1 of 2
ACTIVITY/LOCATION	GSA-WATERTOWN, WATERTOWN MA
SURVEYOR	S. JOHNSON
PHONE	—
MAP I.D.	7-04-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITES WC-1B, B-2

PERMISSIBLE LEVELS	CSCA AREA CONTROL LEVELS	
— dpm/100 cm² ALPHA	N/A dpm/100 cm² ALPHA	☐ OTHER (SEE COMMENTS)
<1000 dpm/100 cm² BETA-GAMMA	N/A dpm/100 cm² BETA-GAMMA	■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2385 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.2 / 5.0	—
MDA	dpm	150 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.3 μR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: Scott A. [illegible] DATE 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV ____ dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				<150		LOCATION SHOWN ON MAP 7-04-01
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SWIPE/PROBE NO	ALPHA EQUIV ____ dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
18				<150		MAP 7-04-01
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CHEM-NUCLEAR SYSTEMS, INC.

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITES IVC-1B, B-2

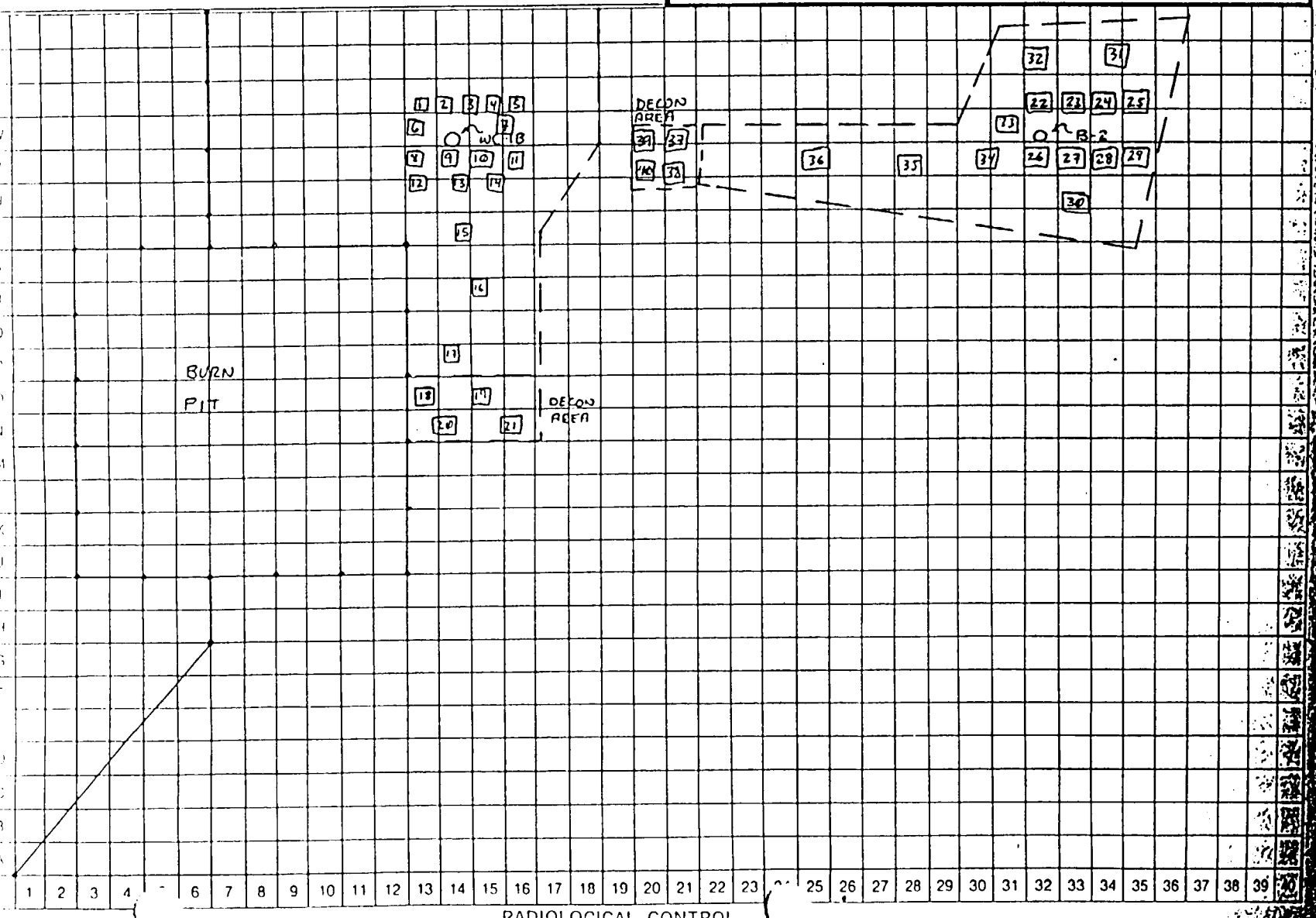
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

PAGE 2 2

SURVEYOR: S. JOHNSON

DATE: 04 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

MAP ID NUMBER: 2-04-01

Scale - 1/4" = ____

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7 ~~6~~-05-01(A)

Project Name/No. GSA-WATERTOWN Date 5 JUL 90

Sample Location DRILL SITE B-6 B-7 Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		8.5 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / #1116 C.F. 4.55 MDA 1.52×10^{-12}

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)
703	20	35	35	0	$< 1.52 \times 10^{-12}$

XMTCD -9-90 745

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm - $\bar{C}_b$	= Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 05 JUL 90 | TIME START: 0845 | TIME COMPL: 1145 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 7-05-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY — DAILY ■ WEEKLY ☐ MONTHLY ☐

COMMENTS: BORINGS B-6, B-7 DRILL SITES

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2386 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.215.0	—
MDA	dpm	150 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.5 μR/hr mR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA — ; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ____ ☐ SPECIAL ____ ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				<150		LOCATION SHOWN ON MAP 7-05-01
2						
3						
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9						
10						
11						
12						
13						
14						
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16						
17						
18				<150		MAP 7-05-01
19						
20						
21					6.5	
22						
23						
24						
25					6.8	
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CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

SUBJECT: DRILLSITES B-6, B-7

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 7-05-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 05 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO.	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
41				<150		MAP 7-05-01

SWIPE/ PROBE NO.	ALPHA EQUIV. ___ dpm/ PROBE	ALPHA EQUIV. ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITES B-6, B-7

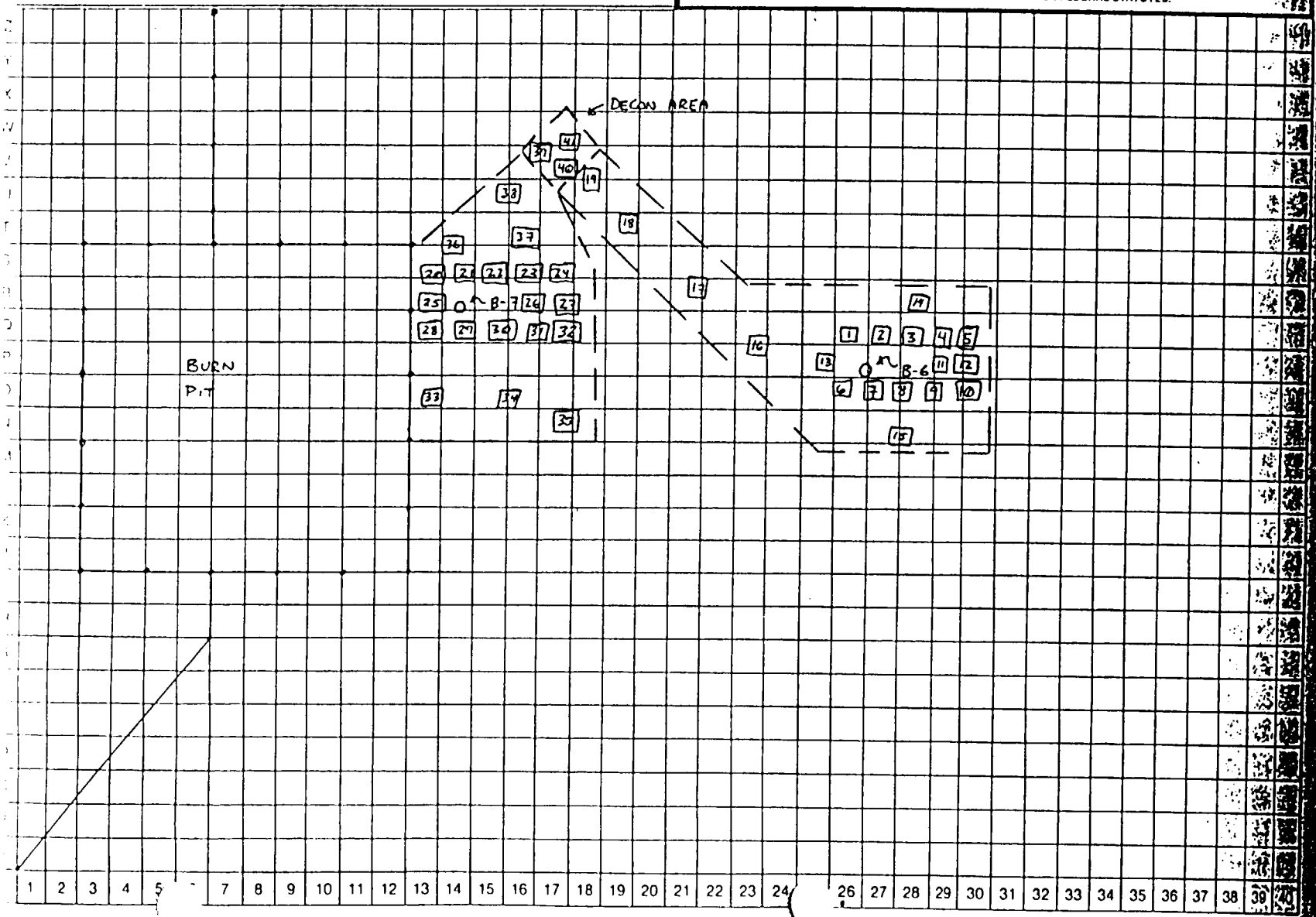
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 3 3

DATE: 05 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



PID NUMBER 25-01

RADIOLOGICAL CONTROL

SCALE 1/4" = ___

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE	DATE: 05 JUL 90	TIME START: 1255	TIME COMP: 1315	PAGE 15 of 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: —

PHONE: —

MAP ID: 7-05-02

DAILY ☐ WEEKLY ■ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ■ MONTHLY ☐ RADIATION SURVEY

COMMENTS: RAM STOWAGE AREA

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <10000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2386 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.2/5.0	—
MDA -	dpm	150 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.5 μR/hr. ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14JUL90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WEEKLY

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1		1-9		<150	7.5	LOCATION SHOWN ON
2					7.2	MAP 7-05-02
3					7.3	
4					7.3	
5					7.2	
6					7.0	
7					7.0	
8					6.8	
9					7.0	
10					7.3	
11					7.4	
12					7.3	
13					6.9	
14					6.8	
15					6.8	
16					7.2	
17					7.0	
18				<150	7.2	MAP 7-05-02
19					7.0	
20					7.3	
21					6.8	
22					7.1	
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: WEEKLY RAM STORAGE AREA

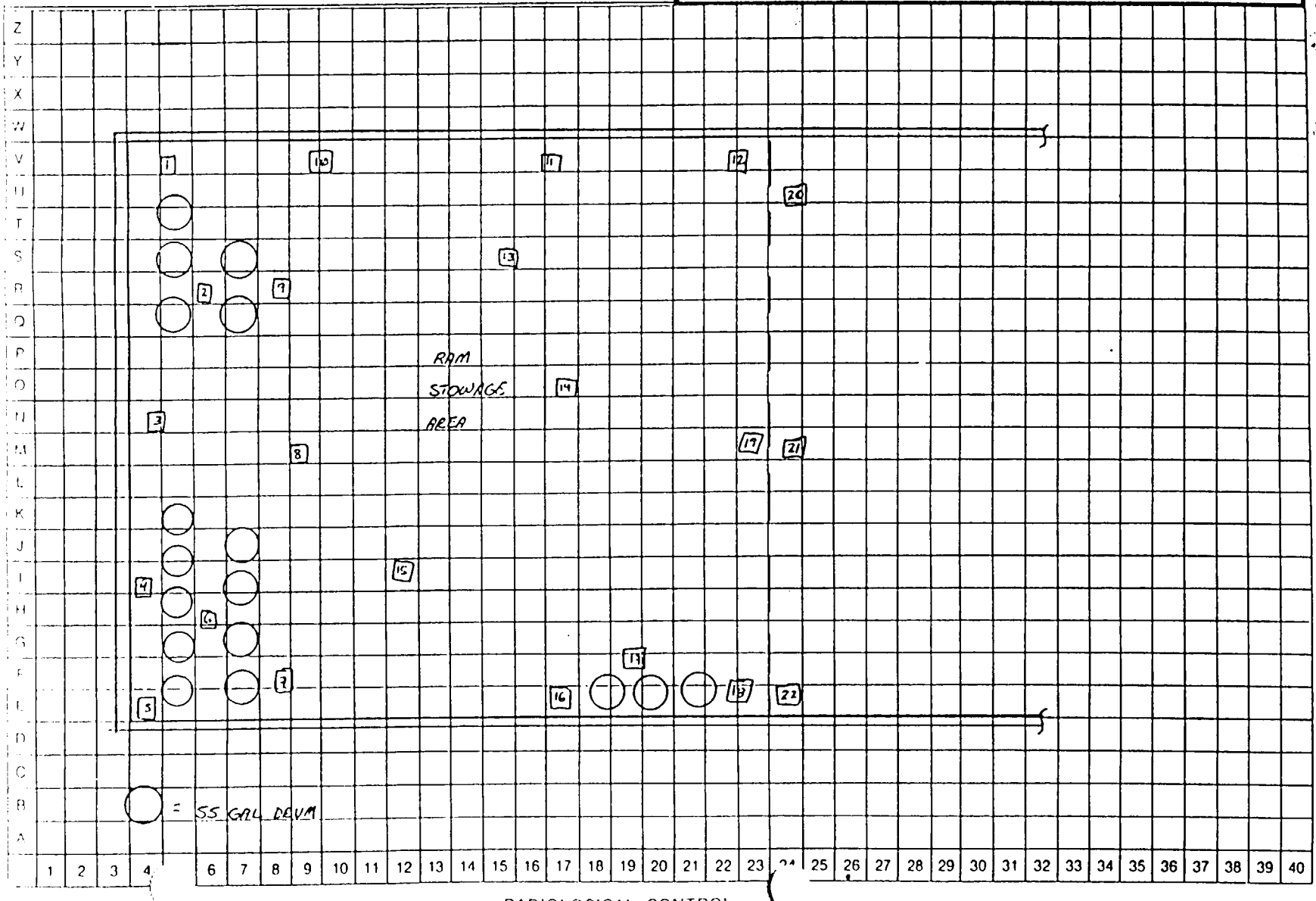
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

PAGE: 2 2

SURVEYOR: S. JOHNSON

DATE: 05 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



GRID NUMBER: 05-02

RADIOLOGICAL CONTROL

Scale - 1/4" = ____

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

DC JUL 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

07 JUL 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

08 JUL 90

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7 ~~16~~-09-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 09 JUL 90

Sample Location DRILL SITES B-1 15, 16 Technician S. JOHNSON

Air Sampler Type/No. BADECO/2055 Filter Used GELMAN A/C

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		10.1 m³

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.55 MDA 1.24×10^{-12}

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)
658	20	~~0.59~~ 33	33	0		$< 1.24 \times 10^{-12}$

COUNTED 7-11-90 21540

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 09 JUL 90 | TIME START: 1015 | TIME COMPL: 1715 | PAGE 1 / 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-09-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITES B-1, B-15, B-16

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	–
SOURCE STRENGTH	dpm	11771 dpm	– mR/hr.
INSTRUMENT RESPONSE	cpm	2545 cpm	– mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22 / 4.55	–
MDA	dpm	136 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.7 μR/HR

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA —; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON —; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1			<136		7.3	LOCATION SHOWN ON
2					8.0	MAP 7-09-01
3					7.5	
4					7.5	
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14						
15						
16						
17						
18			<136			MAP 7-09-01
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CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: DRILL SITES B-1, B-15, B-16

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 7-09-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 09 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<136		MAP 7-09-01
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTRO

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITES B-1, B-15, B-16

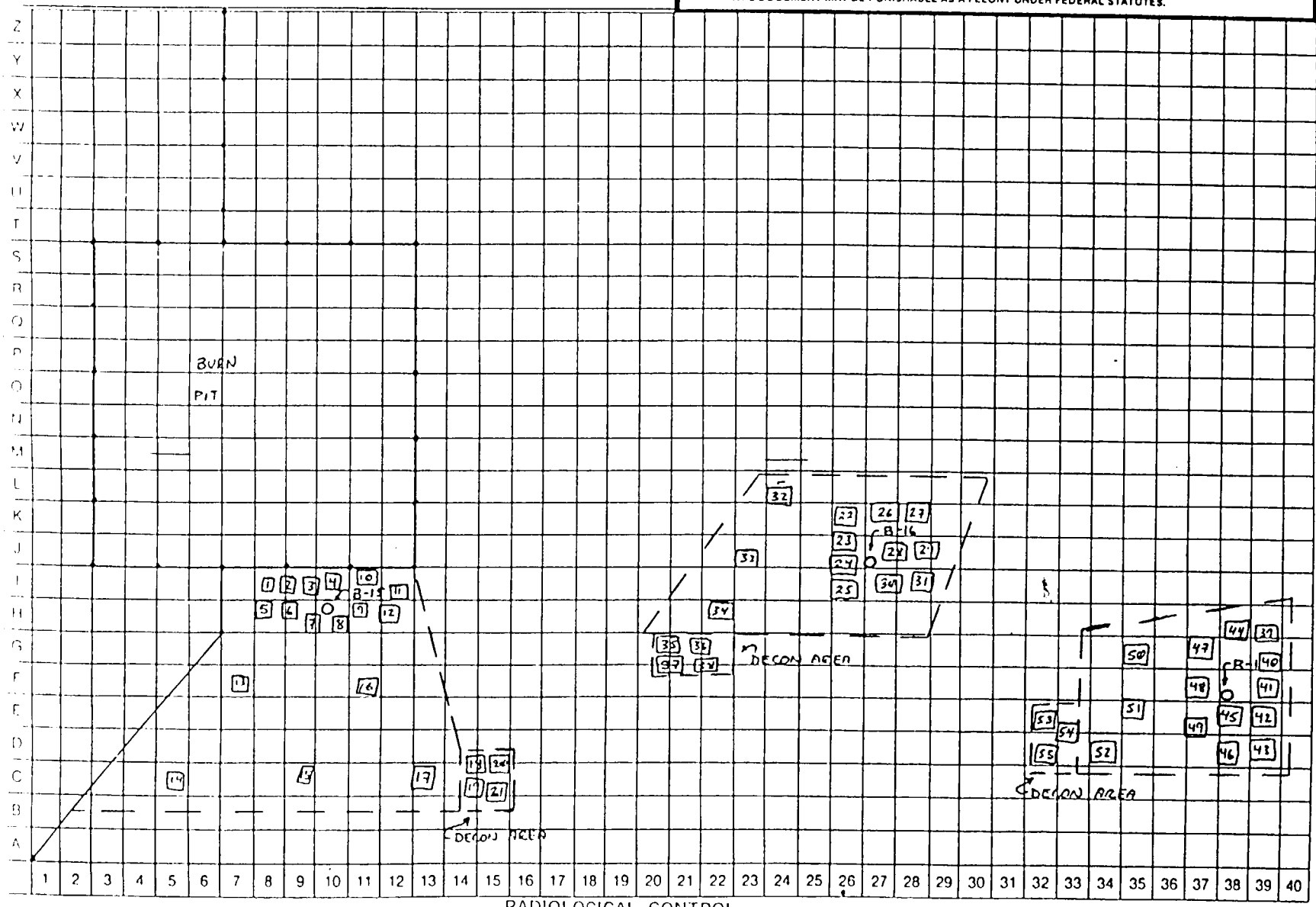
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

PAGE: 3 3

SURVEYOR: S. JOHNSON

DATE: 09 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



MAP I.D. NUMBER 7-09-01

RADIOLOGICAL CONTROL

Scale - 1/4" = —

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-10-01(A)

Project Name/No. GSA-WATERTOWN Date 10 JUL 90

Sample Location DRILL SITE WC-4B Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = (net cpm)x(C.F.) x (4.505 x 10^{-7} uCi/dpm) X Fa / (Sample volume) x (10^3 ml/l) or (2.83 x 10^4 ml/ft3)

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		11.3 m^3

β^- \ γ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.55 MDA 1.10×10^{-12}

COUNTED 7-11-90 @ 1605

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
706		20		35			33		2	$< 1.10 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 10 JUL 90 | TIME START: 1200 | TIME COMPL: 1545 | PAGE 1 OF 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 7-10-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND

DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE WC-48

PERMISSIBLE LEVELS	CSCA AREA CONTROL LEVELS	
— dpm/100 cm² ALPHA	N/A dpm/100 cm² ALPHA	☐ OTHER (SEE COMMENTS)
<1000 dpm/100 cm² BETA-GAMMA	N/A dpm/100 cm² BETA-GAMMA	■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2512 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	148 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	38 cpm	6.5 μR/HR ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —		BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —		BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1			<148 ~~<136~~			LOCATION SHOWN ON MAP 7-10-01
2						
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18			<148 ~~<136~~			MAP 7-10-01
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

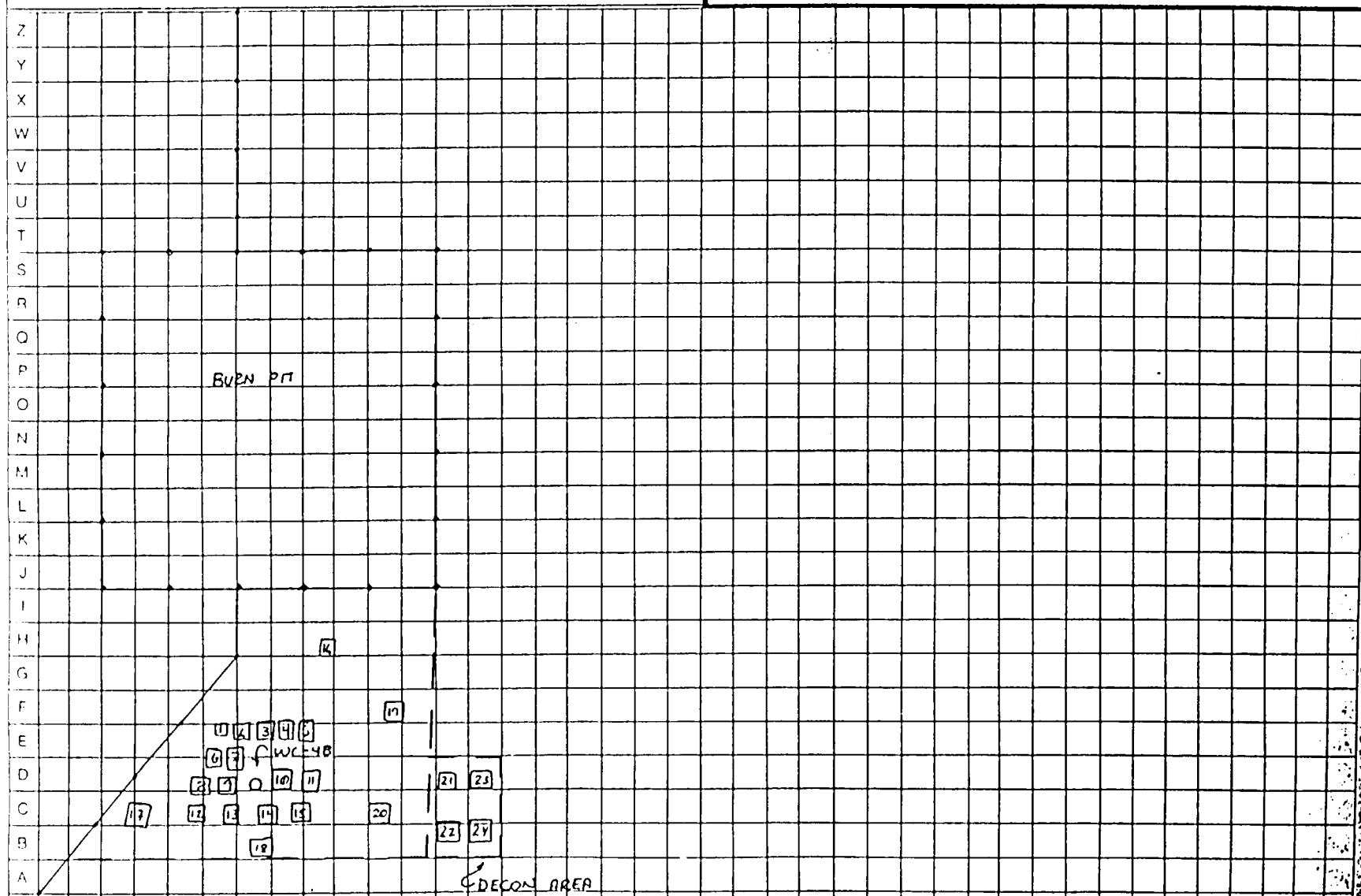
PAGE: 2 OF 2

COMMENTS: DRILL SITE WC-4B

SURVEYOR: S. JOHNSON

DATE: 10 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



MAP I.D. NUMBER 1-10-01

RADIOLOGICAL CONTROL

Scale - 1/4" = ____

CHEM-NUCLEAR SYSTEMS, INC.

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-11-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 11 JUL 90

Sample Location ~~DRILL SITE WC-10(A)~~ WC-10B Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		14.3 m^3

β^-\ γ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 9.54×10^{-13}

COUNTED 7-14-90 @ 1108

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)
679	20	34	36		0	$< 9.54 \times 10^{-13}$
			2σ			

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^-/γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

CONTAMINAT[illegible] RADIATION SURVEY REP[illegible]

TO: PROJECT FILE

DATE: 11 JUL 90 | TIME START: 1030 | TIME COMP: 1310 | PAGE 1 [illegible] 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-11-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE WC-10B

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; ≤1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA	BETA-GAMMA
	—	ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON	BETA-GAMMA
	—	ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2465 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	<143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.3 μR/hr mR/hr.

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1			<143			LOCATION SHOWN ON
2						MAP 7-11-01
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18			<143			MAP 7-11-01
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN/WATERTOWN, MA

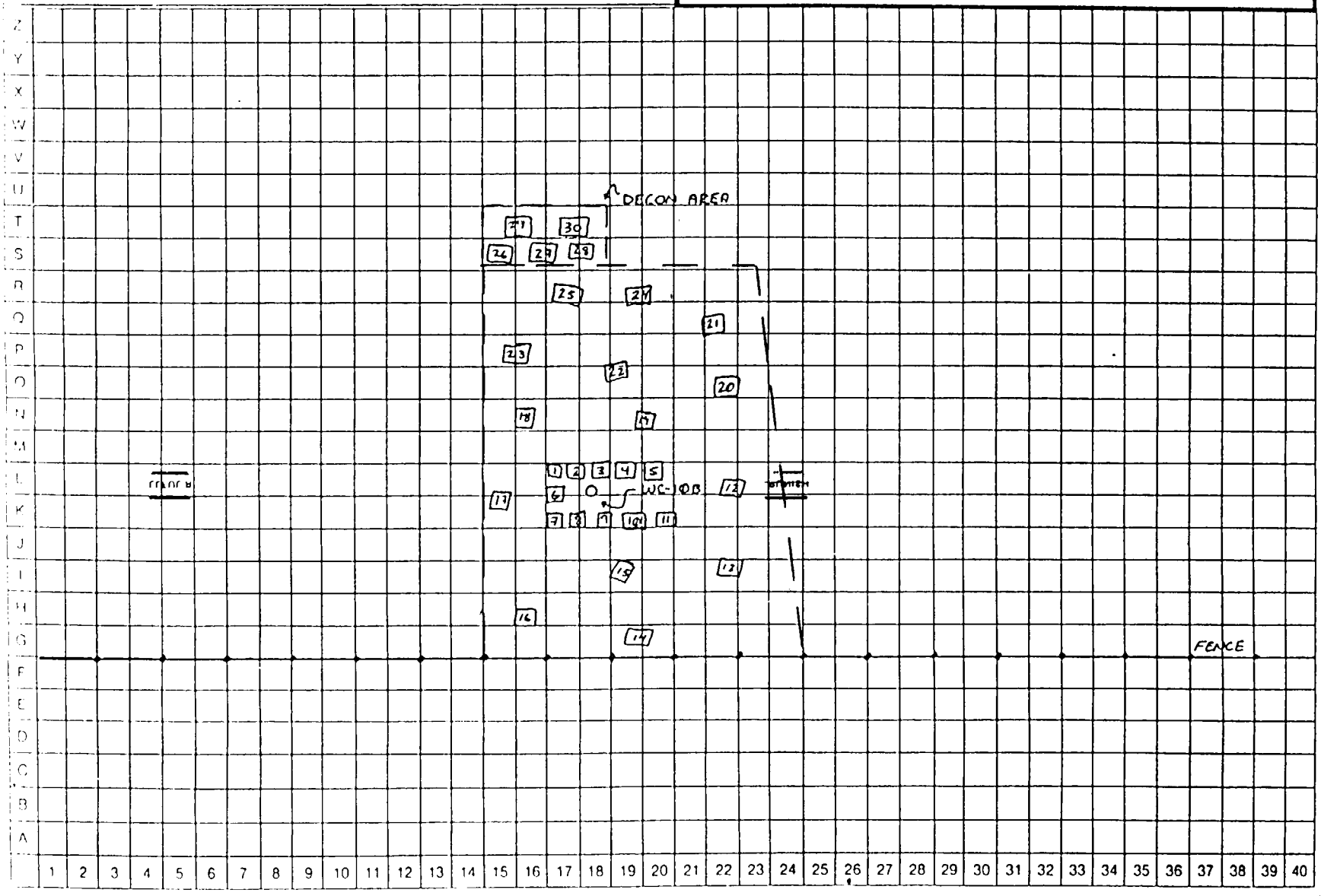
PAGE 2 2

COMMENTS: DRILL SITE WC-10B

SURVEYOR: S. JOHNSON

DATE: 11 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

WAPID NUMBER 7-11-01

RADIOLOGICAL CONTROL

Scale - 1/4" = ___

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-12-01(A)

Project Name/No. GSA-WATERTOWN/46019 Date 12 JUL 90

Sample Location DRILL SITE WC-58 Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
-	-	-		-		18.1 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.76 MDA 7.52×10^{-13}

COUNTED 7-14-90 1128

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)
669	20	33	36	0		$< 7.52 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 12 JUL 90 | TIME START: 1000 | TIME COMPL: 1530 | PAGE 1 / 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: 7-12-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: DRILL SITE WC-5B

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2645 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	136 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.3 mR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA — ; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1			<136			LOCATION SHOWN ON MAP 7-12-01
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18			<136			MAP 7-12-01
19						
20						
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CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE WC-5B

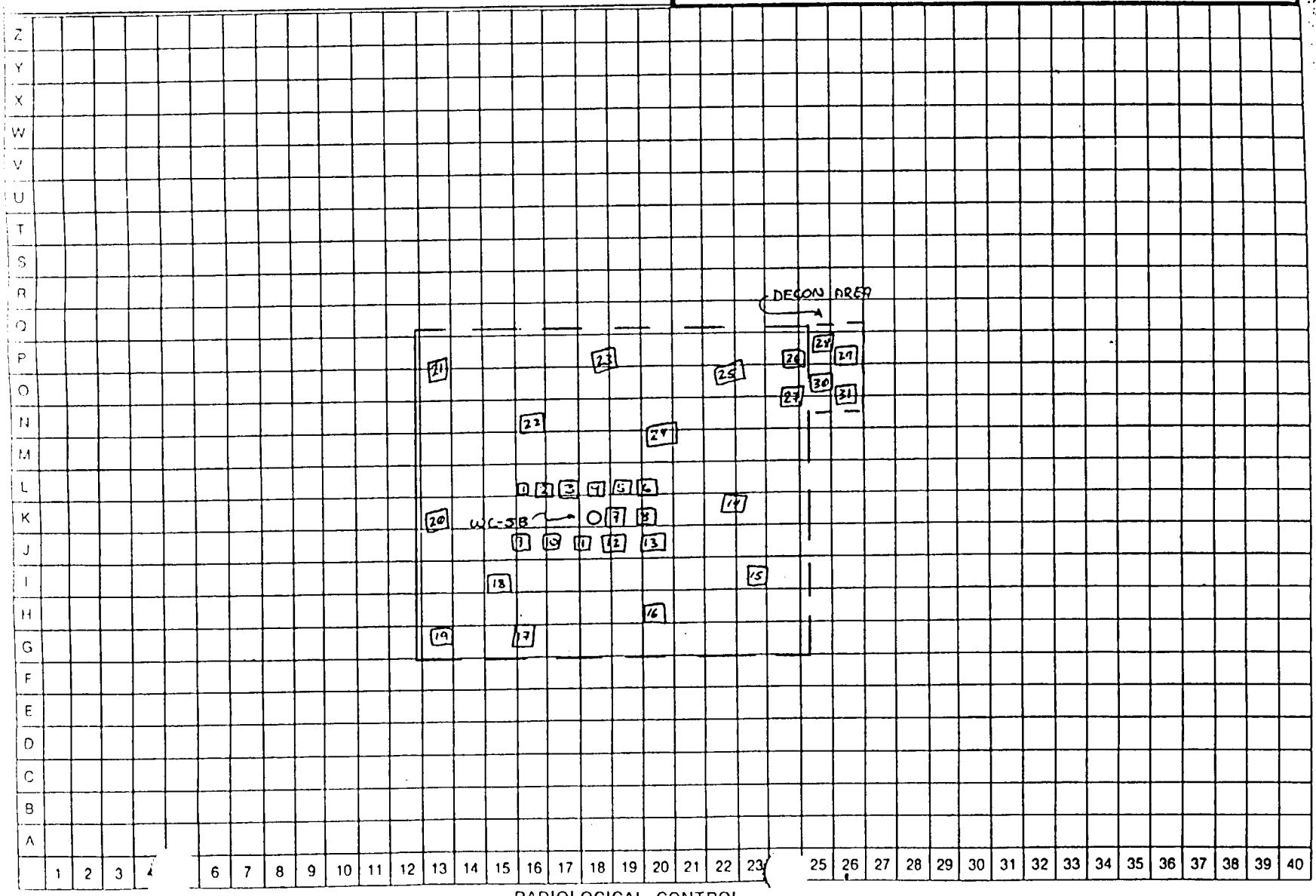
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE: 2 2

DATE: 12 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC.

WORLD NUMBER 3-13-01

Scale 1/4" = 1'

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE	DATE: 12 JUL 90	TIME START: 1655	TIME COMPL: 1715
			PAGE 1 OF 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA	SURVEYOR: S. JOHNSON	PHONE: —
	MAP I.D.: 7-12-02	

DAILY ☐ WEEKLY ■ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY DAILY ☐ WEEKLY ■ MONTHLY ☐

COMMENTS: WEEKLY SURVEY OF RAM STOWAGE AREA

PERMISSIBLE LEVELS	CSCA AREA CONTROL LEVELS	
— dpm/100 cm² ALPHA	N/A dpm/100 cm² ALPHA	☐ OTHER (SEE COMMENTS)
<1000 dpm/100 cm² BETA-GAMMA	N/A dpm/100 cm² BETA-GAMMA	■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2645 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA -	dpm	136 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.3 nR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESR-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESR2 #803

RADCON REVIEW [signature] DATE 14 JUL 90

REASON FOR SURVEY ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE SEE COMMENTS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1		—		<136	7.1	LOCATION SHOWN ON
2					6.9	MAP 7-12-02
3					7.0	
4					7.2	
5					7.0	
6					6.8	
7					7.2	
8					7.4	
9					7.0	
10					6.8	
11					7.2	
12					7.3	
13					7.3	
14					7.2	
15					7.2	
16					7.2	
17					7.3	

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV — dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION
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23		~~CGL~~				
24		—				
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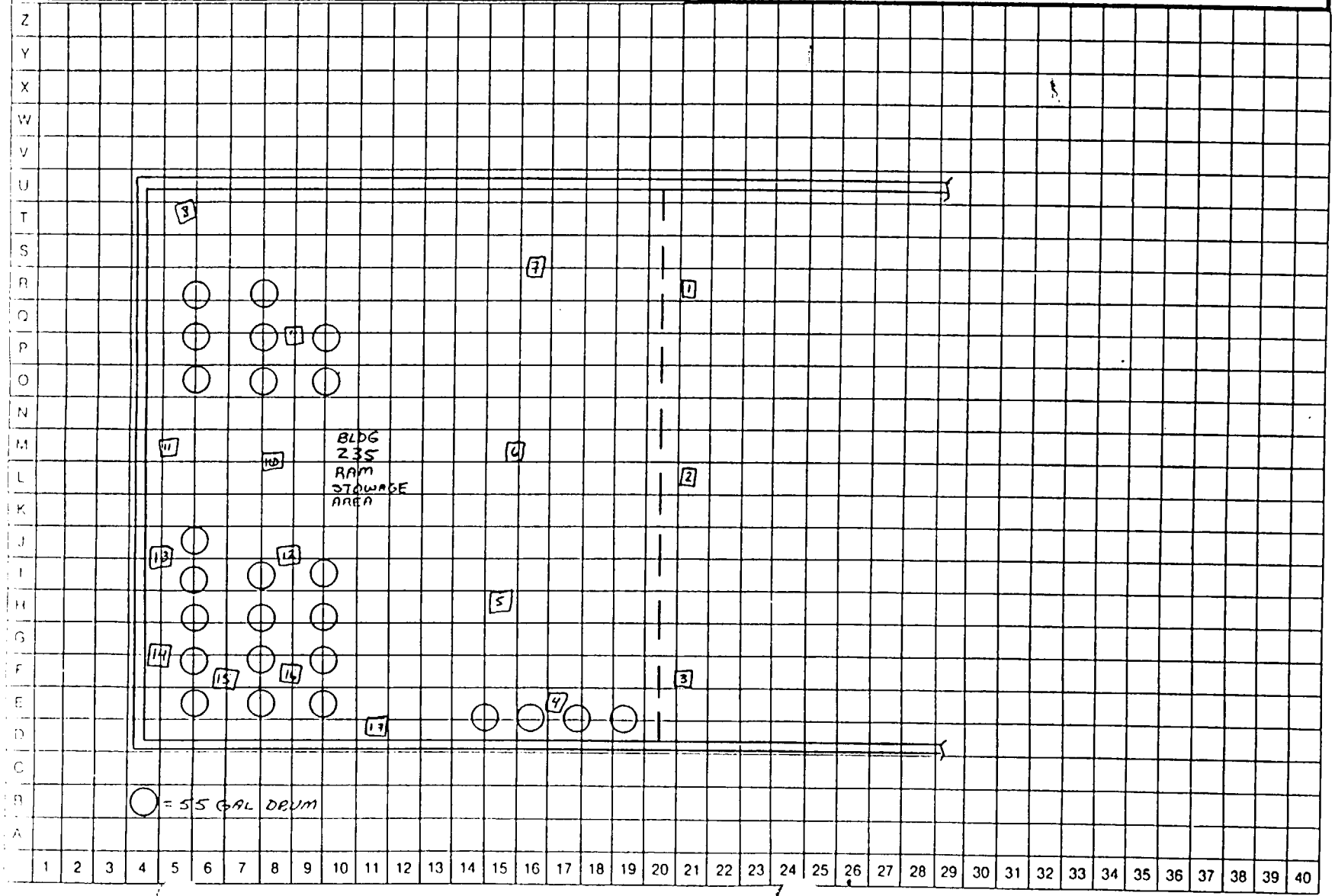
CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA	PAGE 2 2	
COMMENTS: WEEKLY SURVEY OF RAM STOWAGE AREA	SURVEYOR: S. JOHNSON	DATE: 12 JUL 90	

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



MAP ID NUMBER 12-02 RADIOLOGICAL CONTROL 1" = 1/4" = —

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-13-01(A)

Project Name/No. GSA-WATERTOWN/460M Date 13 JUL 90 + 1

Sample Location DRILL SITE WC-5B Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = (net cpm)x(C.F.) x (4.505 x 10^{-7} uCi/dpm) X Fa / (Sample volume) x (10^3 ml/l) or (2.83 x 10^4 ml/ft3)

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		12.6 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.76 MDA 1.08×10^{-12}

COUNTED 7-14-90 @ 1149

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)
768	20	38	36	2		$< 1.08 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$ =	Net cpm	Activity (uCi/ml)

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 13 JUL 90 | TIME START: 1200 | TIME COMPL.: 1415 | PAGE 1 of 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-13-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: DRILL SITE WC-5C

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2553 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	141 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	37 cpm	6.5 μR/hr. mR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO.: ALPHA — ; BETA-GAMMA ESP-1 #116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO.: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 14 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
1			<141			LOCATION SHOWN ON MAP 7-13-01
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12						
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14						
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16						
17						

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~ GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
18			<141			MAP 7-13-01
19						
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE WC-5C

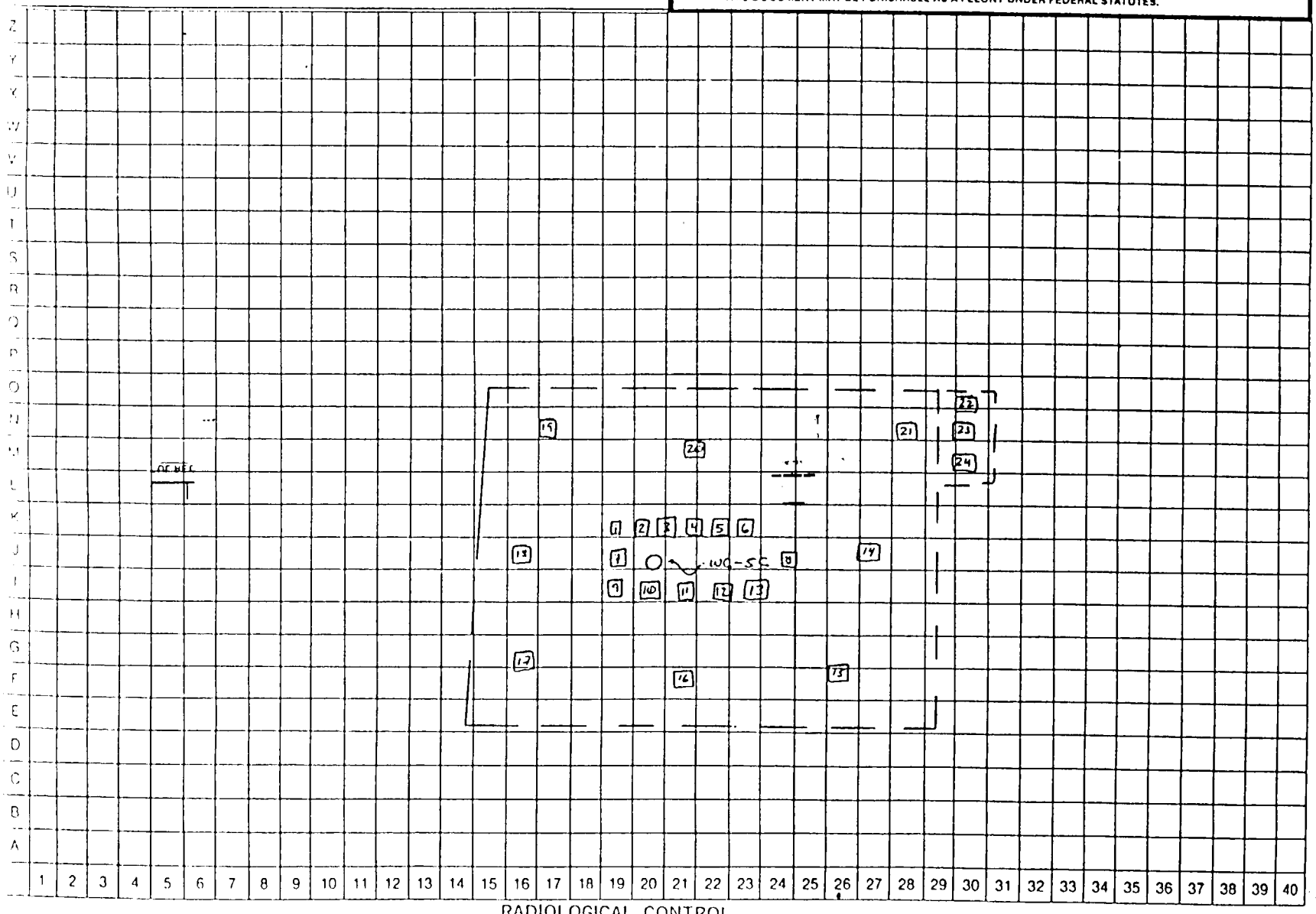
ACTIVITY/LOCATION: GSA WATERTOWN / WATERTOWN, MA

PAGE 2 2

SURVEYOR: S. JOHNSON

DATE: 13 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

RAD ID NUMBER 7-13-01

Scale - 1/4" =

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

14 JUL 90

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 15 JUL 90 | TIME START: 1415 | TIME COMPL.: 1530 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSR-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-15-01

☐ DAILY ☐ WEEKLY ☐ MONTHLY CONTAMINATION AND ☐ DAILY ☐ WEEKLY ☐ MONTHLY RADIATION SURVEY

COMMENTS: PRE-WORK SURVEY OF BURN PIT

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; ≤10000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2446 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.76	—
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.5 mR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 21 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ■ SPECIAL SEE COMMENTS ☐ ROUTINE

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1					7.5	LOCATION SHOWN ON
2					8.0	MAP 7-15-01
3					8.5	
4					8.0	
5					7.5	
6					8.0	
7					11.0	
8					30.0	(GROUND LEVEL)
9					7.0	
10					7.0	
11					7.0	
12					6.7	
13					7.5	
14					7.0	
15					7.0	
16					6.5	
17					7.2	
18					7.0	MAP 7-15-01
19					6.8	
20					7.6	
21					6.5	
22					6.0	
23					5.8	
24					6.9	
25					7.1	
26					8.0	
27					7.2	
28					7.3	
29					7.2	
30					7.8	
31					7.2	
32					7.2	
33					7.3	
34					7.0	
35					8.0	
36					14.0	(FENCE POST HOLE)
37					7.4	
38					8.3	
39					7.0	
40					8.7	

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CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

SUBJECT: PRE-WORK SURVEY OF BURN PIT

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: 7-15-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 15 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41					8.5	MAP 7-15-01
42					8.6	
43				<143		
44				<143		
45				4641		
46				<143		
47				<143		
48				<143		
49				<143		
50				9282		
51				<143		
52				3094		
53				9282		
54				6188		
55				10829		
56				6188		
57 ~~691~~				3094		
58				<143		
59				3094		
60				<143		
61				<143		
62				<143		
63				<143		
64				<143		
65				2166		
66				<143		

SWIPE/ PROBE NO	ALPHA EQUIV. ___ dpm/ PROBE	ALPHA EQUIV. ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
67				<143		MAP 7-15-01
68				<143		
69				<143		
70				<143		
71				<143		
72				2475		
73				2475		
74				6188		
75				9282		
76				6188		
77				<143		
78				<143		
79				<143		
80				2475		
81				<143		
82				<143		
83				2166		
84				<143		
85				<143		
86				<1	6.8	
87					7.5	
88					7.5	
89					7.8	

ND - Not Detectable

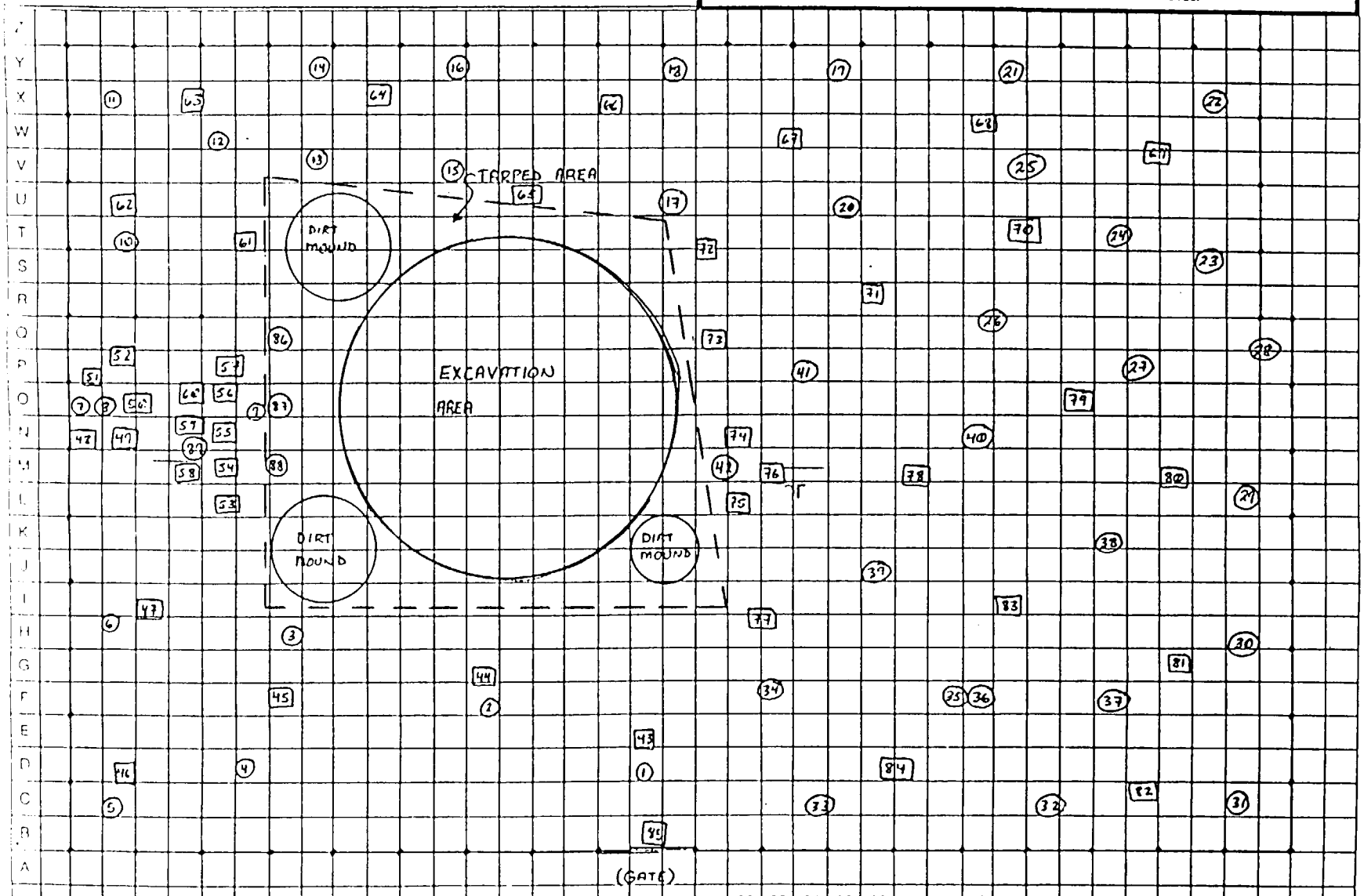
RADIOLOGICAL CONTRO

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA	PAGE 3 3
COMMENTS: BURN PIT PRE-WORK SURVEY	SURVEYOR: S. JOHNSON	DATE: 15 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

MAP ID NUMBER 7-15-01

Scale - 1/4" = ____

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-16-01(A)

Project Name/No. GSA-WATERTOWN / 46019 Date 16 JUL 90

Sample Location DRILL SITES B-20, W-7A, W-11A Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		15.3 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.76 MDA 9.03×10^{-13}

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)
756	20	38	37	1		$< 9.03 \times 10^{-13}$

OUNTED
-18-90
1735

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts ÷	Count Time =	cpm	cpm -	$\bar{C}_b$	= Net cpm	Activity (uCi/ml)

RADIOLOGICAL CONTROL

CONTAMINATION RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 16 JUL 90 | TIME START: 0820 | TIME COMPL: 1550 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-16-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY DAILY ■ WEEKLY ☐ MONTHLY ☐

COMMENTS: DRILL SITES B-20, W-7A, W-11A

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; ≤1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2477 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	138 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	6.5 μR/HR ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA — ; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON — ; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE: 21 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO.	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<138			LOCATION SHOWN ON
2						MAP 7-16-01
3						
4						
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17						
18			<138			MAP 7-16-01
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THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL [illegible]

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 7-16-01

COMMENTS: DRILL SITE B-20, W-7A, W-11A

SURVEYOR: S. JOHNSON

DATE: 16 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
41				<138		MAP 7-16-01
42						
43						
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SWIPE/ PROBE NO	ALPHA EQUIV. ___ dpm/ PROBE	ALPHA EQUIV. ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr. ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN/WATERTOWN, MA

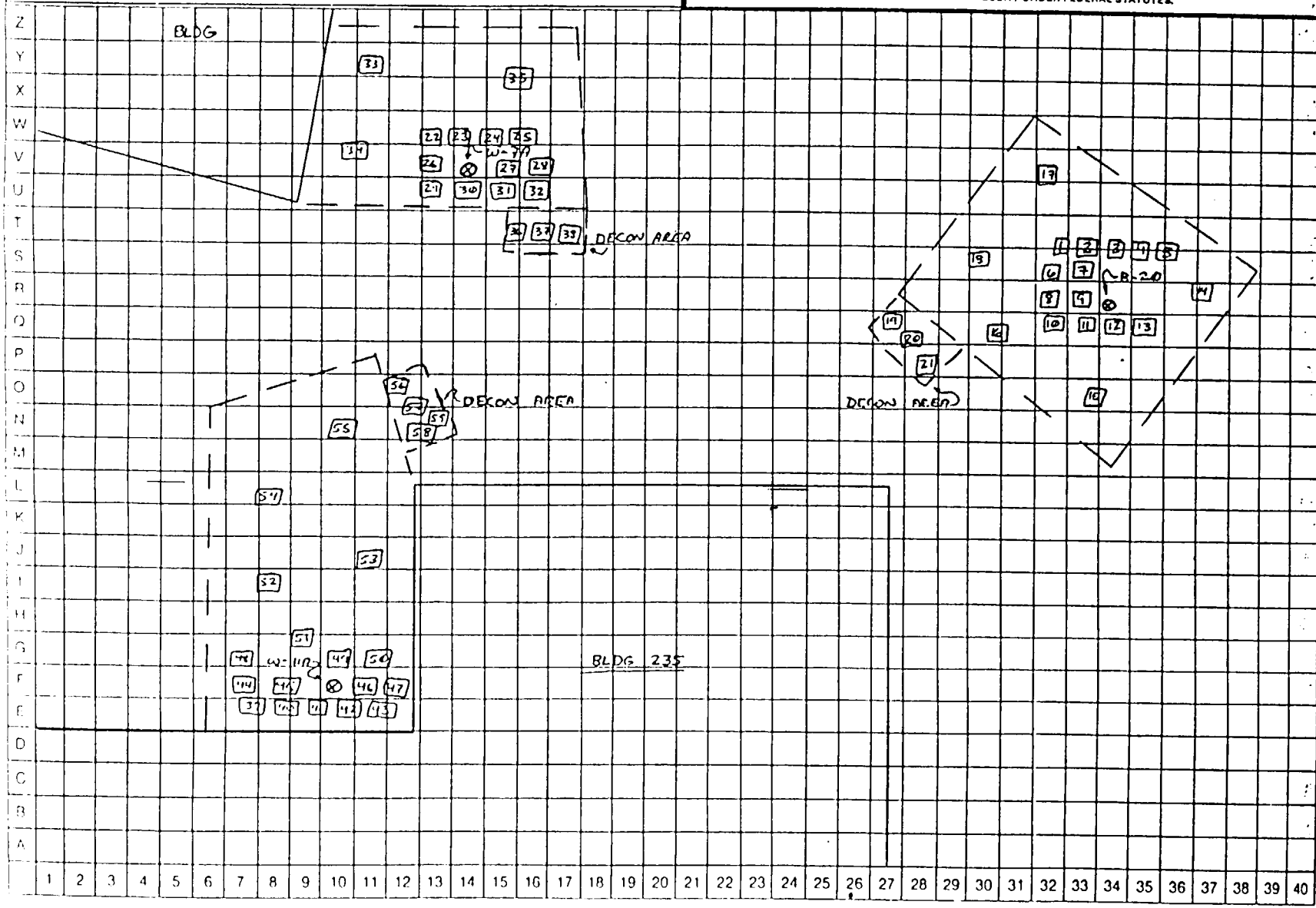
PAGE: 3 3

COMMENTS: DRILL SITES B-20, W-7A, W-11A

SURVEYOR: S. JOHNSON

DATE: 16 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



MAP ID NUMBER 7-16-90

RADIOLOGICAL CONTROL

Scale - 1/4" = —

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-17-01(A)

Project Name/No. GSA WATERTOWN/46019 Date 17 JUL 90

Sample Location DRILL SITE W-9A Technician S. JOHNSON

Air Sampler Type/No. RADECO/2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		7.0 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# _____ C.F. 4.76 MDA 1.98×10^{-12}

COUNTED 7-18-90 @ 1300

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
777		20		39			37		2	$< 1.98 \times 10^{-12}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE	DATE: 17 JUL 90	TIME START: 0800	TIME COMPL: 0940
			PAGE 1 of 2

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN MA	SURVEYOR: S. JOHNSON	PHONE: —
	MAP ID: 7-17-01	

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: DRILL SITE W-9A

PERMISSIBLE LEVELS	CSCA AREA CONTROL LEVELS	
— dpm/100 cm² ALPHA	N/A dpm/100 cm² ALPHA	☐ OTHER (SEE COMMENTS)
<1000 dpm/100 cm² BETA-GAMMA	N/A dpm/100 cm² BETA-GAMMA	■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS		RADIATION
	ALPHA	BETA/GAMMA	BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2587 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.22/4.55	—
MDA	dpm	132 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	33 cpm	6.5 μR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW [signature] DATE 21 JUL 90

REASON FOR SURVEY
- ☐ PROCEDURE—NO
- ☐ SPECIAL
- ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<132			LOCATION SHOWN ON
2						MAP 7-17-01
3						
4						
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6						
7						
8						
9						
10						
11						
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18			<132			MAP 7-17-01
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CHEM-NUCLEAR SYSTEMS INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: DRILL SITE W-9A

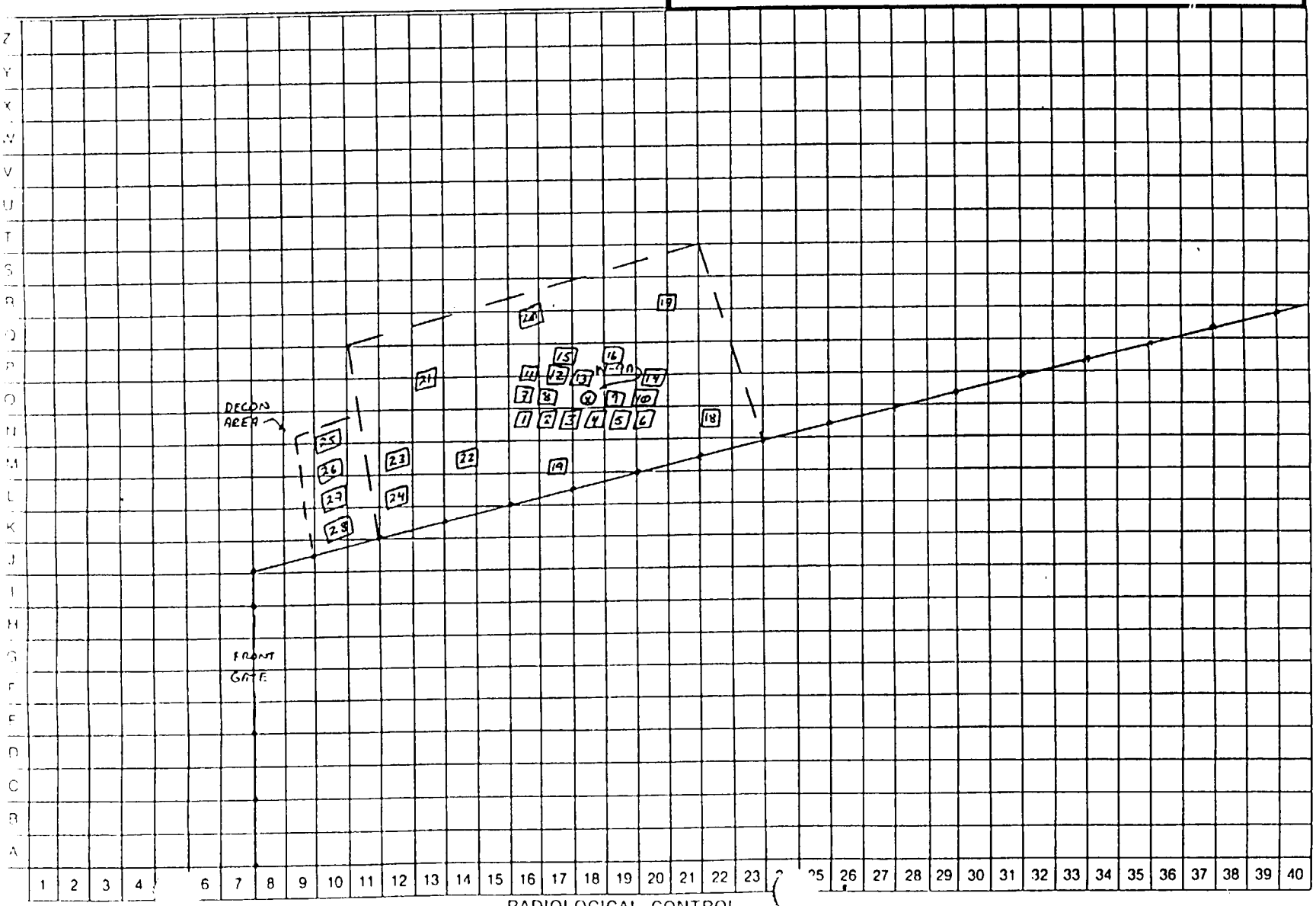
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

PAGE: 2 2

SURVEYOR: S. JOHNSON

DATE: 17 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

MAP I.D. NUMBER 17-01

1/4" =

CHEM-NUCLEAR SYSTEMS, INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-18-01(A)

Project Name/No. GSA-WATERTOWN / 4609 Date 18 JUL 90

Sample Location BURN PIT (B-8, B-11) Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = (net cpm)x(C.F.) x (4.505 x 10^{-7} uCi/dpm) X Fa / (Sample volume) x (10^3 ml/l) or (2.83 x 10^4 ml/ft3)

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
—	—	—		—		12.3 m^3

COUNTED 7-20-90 10755

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1 / 1116 C.F. 4.36 MDA 1.11×10^{-12}

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
687		20		34			36		0	$< 1.11 \times 10^{-12}$
							25916			

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINATION/RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 18 JUL 90 | TIME START: 0720 | TIME COMPL: 1600 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-18-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND RADIATION SURVEY

COMMENTS: BURN PIT – B-8, B-11

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	–
SOURCE STRENGTH	dpm	11791 dpm	– mR/hr.
INSTRUMENT RESPONSE	cpm	2465 cpm	– mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.76	–
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.3 nR/hr ~~mR/hr~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA —; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON —; BETA-GAMMA ESP-2 #803

RADCON REVIEW: Scott A. [illegible] DATE: 21 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE–NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO	ALPHA EQUIV dpm/PROBE	ALPHA EQUIV dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				928	7.5	LOCATION SHOWN ON
2				619	7.6	MAP 7-18-01
3				928	7.2	
4				928	7.5	
5				619	7.3	
6				1238	7.2	
7				619	7.5	
8				619	7.2	
9				<143		
10						
11						
12						
13						
14						
15						
16						
17						
18				<143		MAP 7-18-01
19						
20						
21						
22						
23						
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25						
26						
27						
28						
29				6188	8.6	
30				6188	8.8	
31				7282	8.6	
32				6188	8.6	
33				1547	7.8	
34				2166	8.7	
35				<143		
36						
37						
38						
39						
40						

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CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA WATERTOWN / WATERTOWN, MA

MAP ID: 7-18-01

PAGE 2 OF 3

PROJECT: BURN PIT - B-8, B-11

SURVEYOR: S. JOHNSON

DATE: 18 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143		MAP 7-18-01
42						
43						
44						
45						
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66						

SWIPE/PROBE NO	ALPHA EQUIV. ___ dpm/PROBE	ALPHA EQUIV. ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
67				<143		MAP 7-18-01
68						

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE

COMMENTS: BURNPIT - B-3, D-11

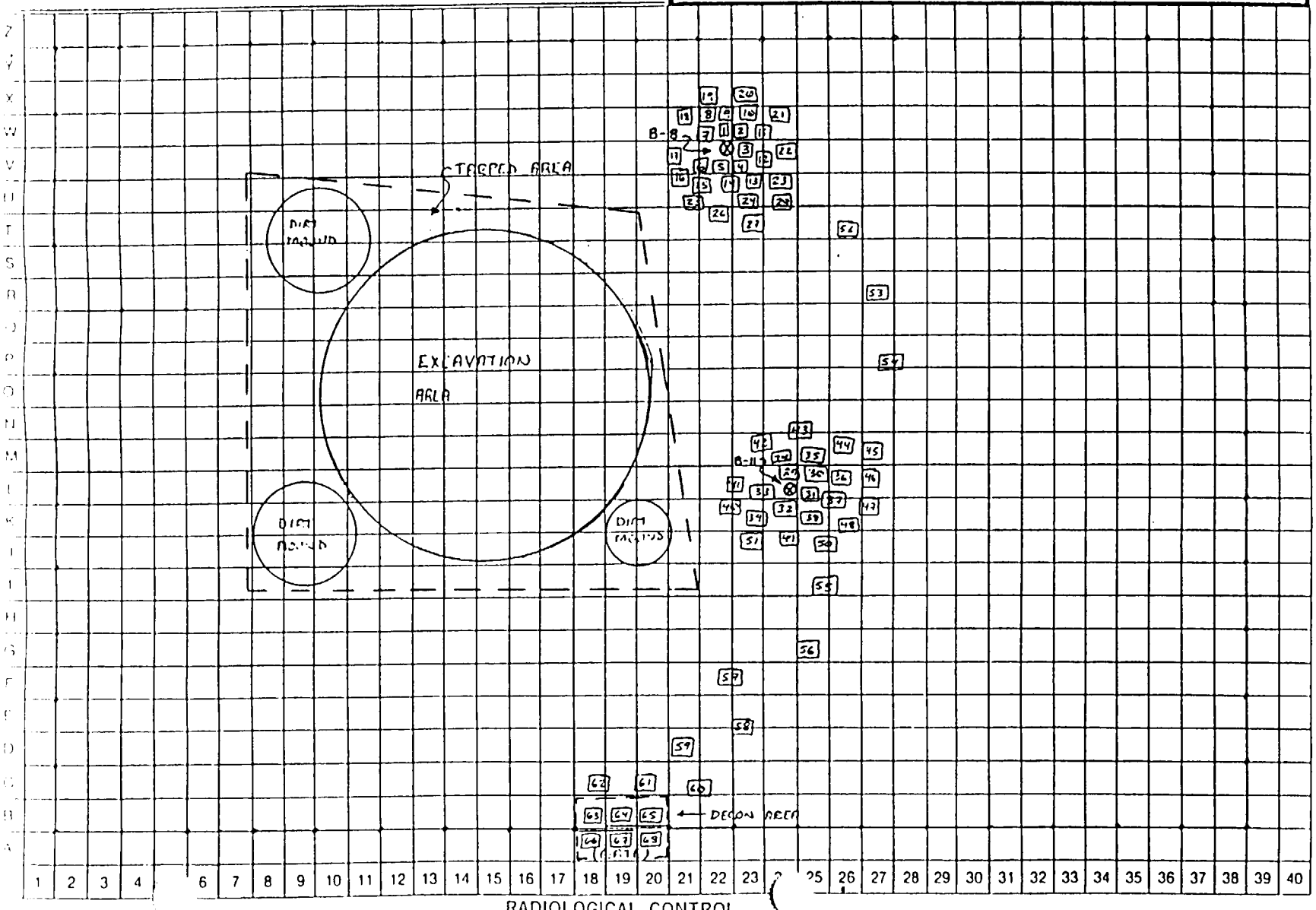
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN MA

PAGE 3 OF 3

SURVEYOR: S. JOHNSTON

DATE: 13 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

GRID NUMBER B-D1

1/4" =

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

AIRBORNE RADIOACTIVITY SAMPLE/MONITOR REPORT No. 7-19-01(A)

Project Name/No. GSA-WATERTOWN / 46019 Date 19 JUL 90

Sample Location BUENPIT (B-9, 10) Technician S. JOHNSON

Air Sampler Type/No. RADECO / 2055 Filter Used GELMAN A/E

Activity (uCi/ml) = $\frac{\text{(net cpm)x(C.F.) x (4.505 x } 10^{-7} \text{ uCi/dpm) X Fa}}{\text{(Sample volume) x (}10^3\text{ ml/l) or (2.83 x }10^4\text{ ml/ft3)}}$

Fa = 1.25 for Alpha
Fa = 1.00 for Other Emitters

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume
–	–	–		–		15.8 m^3

$\beta^- \backslash \gamma$ Counting Inst./Serial# ESP-1/1116 C.F. 4.76 MDA 8.61×10^{-13}

COUNTED 20-90 0821

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)
737		20		37			36		1	$< 8.61 \times 10^{-13}$

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

Sample Location _____ Technician _____

Air Sampler/# _____ Filter Used _____

Time Sampler on	Sampler off	Total time	X	Flow Rate	=	Sample Volume

β^- / γ Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

α Counting Inst./Serial# _____ C.F. _____ MDA _____

Total Counts	÷	Count Time	=	cpm	cpm	-	$\bar{C}_b$	=	Net cpm	Activity (uCi/ml)

CONTAMINAT RADIATION SURVEY REP

TO: PROJECT FILE

DATE: 19 JUL 90 | TIME START: 0715 | TIME COMPL: 1630 | PAGE 1 of 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON

PHONE: —

MAP ID: 7-19-01

DAILY ■ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND

DAILY ■ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: BURNPIT - B-9, B-10

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO.: ALPHA —; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO.: NEUTRON —; BETA-GAMMA ESP-2 #1003

RADCON REVIEW: [signature] DATE: 21 JUL 90

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE ID		U-238	—
SOURCE STRENGTH	dpm	11771 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2456 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	—
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	34 cpm	6.5 mR/HR ~~mR/hr.~~

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE WORK IN PROGRESS

SWIPE/PROBE NO.	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1				6188	7.5	LOCATION SHOWN ON
2				6188	7.8	MAP 7-19-01
3				9282	7.6	
4				6188	7.5	
5				3094	7.5	
6				1547	7.6	
7				<143		
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

SWIPE/PROBE NO.	ALPHA EQUIV ..... dpm/PROBE	ALPHA EQUIV ..... dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr. ■	ITEM OR LOCATION
18				<143		MAP 7-19-01
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30				1547	7.9	
31				<143	8.0	
32						
33						
34						
35				2166	8.1	
36				<143	7.8	
37						
38						
39						
40						

THE KNOWING & WILL CORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE P ILE AS A FELONY UNDER FEDERAL STATUTES

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: BURN PIT B-7, 8-10

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 7-19-01

PAGE 2 OF 3

SURVEYOR: S. JOHNSON

DATE: 19 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr. ☐ ~~BETA-GAMMA~~ ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143		MAP 7-19-01
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						

SWIPE/ PROBE NO	ALPHA EQUIV. ___ dpm/ PROBE	ALPHA EQUIV. ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

ND - Not Detectable

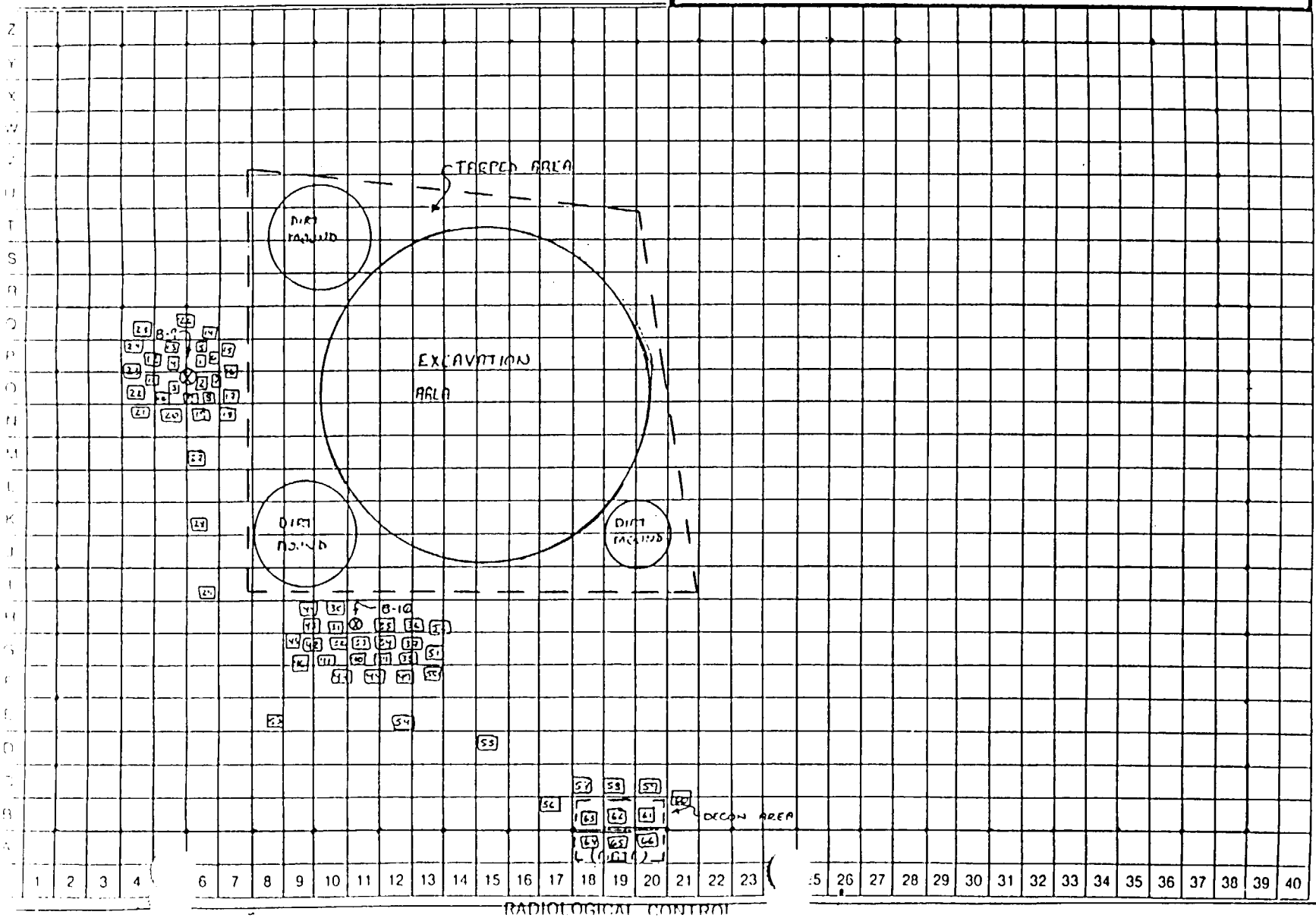
RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

TO: PROJECT FILE	ACTIVITY/ LOCATION: GNA-WATERTOWN / WATERTOWN MA	PAGE 3 OF 3	
COMMENTS: BURNPIT - B-9, B-10	SURVEYOR: S JOHNSON	DATE: 19 JUL 90	

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



CHEM-NUCLEAR SYSTEMS INC

RADIOLOGICAL CONTROL

CONTAMINAT IADIATION SURVEY REP

TO: PROJECT FILE

ATE: 20 JUL 90 | TIME START: 0706 | TIME COMPL: 1038 | PAGE 1 E 4

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: –

MAP I.D.: +A NONE

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: RELEASE SURVEY OF GEO-LOGIC DRILL RIG

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; ≤1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	–
SOURCE STRENGTH	dpm	11771 dpm	– mR/hr.
INSTRUMENT RESPONSE	cpm	2415 cpm	– mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	–
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.5 μR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO: ALPHA —; BETA-GAMMA ESP-1 #1116

RADIATION SURVEY INSTRUMENT TYPE/TAG NO: NEUTRON —; BETA-GAMMA ESP-2 #803

RADCON REVIEW: [signature] DATE 21 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ____ ■ SPECIAL RELEASE OF DRILL RIG ☐ ROUTINE ____

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1		2	<143			DRIVERS DOOR OUTSIDE HANDLE
2						CAB MONI HOLD
3						DRIVERS DOOR INSIDE HANDLE
4						SEAT BACK
5						SEAT BOTTOM
6						FIRE EXTINGUISHER
7						FLOOR
8						CLUTCH PEDAL
9						BRAKE PEDAL
10						GAS PEDAL
11						FLOOR
12						STEERING WHEEL
13						STEERING WHEEL
14						DASHBOARD
15						INSIDE WINDSHIELD
16						GEAR SHIFT
17						INSIDE REAR WINDOW
18			<143			CAB ROOF INSIDE
19						DRIVERS SIDE MIRROR
20						WINDSHIELD (OUTSIDE)
21						WATER TANK (LEFT SIDE)
22						FUEL TANK
23						FUEL TANK STEP
24						FUEL TANK FRONT SIDE
25						LEFT FRONT FENDER
26						LEFT SIDE OF HOOD
27						BUMPER (FRONT SIDE)
28						BUMPER (BACKSIDE)
29						RIGHT SIDE OF HOOD
30						RIGHT FRONT FENDER
31						RIGHT DOOR HANDLE
32						RIGHT SIDE STEP
33						WATER TANK (RIGHT SIDE)
34						RIGHT RACK
35						RIGHT RACK
36						DECK
37						RIGHT TOOL BOX DOORS
38						RIGHT TOOL BOX (INSIDE)
39						RIGHT TOOL BOX (INSIDE)
40						DECK

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

COMMENTS: RELEASE SURVEY OF GEO-LOGIC DRILL RIG

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

MAP ID: NONE

PAGE 2 OF 4

SURVEYOR: S. JOHNSON

DATE: 20 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143		BOOM BASE
42						FEED/ROTATION PRESSURE CONTROL KNOBS
43						DRILL CONTROL PANEL
44						DRILL CONTROL PANEL LEVERS
45						LEFT TAILLIGHT
46						JACK HYDRAULIC MANIFOLD
47						DECK
48						1" DISCHARGE HOSE
49						DECK
50						LEFT RACK
51						LEFT RACK
52						DECK
53						LEFT TOOL BOX DOORS
54						LEFT TOOL BOX (INSIDE)
55						LEFT TOOL BOX (INSIDE)
56						CAB ROOF (OUTSIDE)
57						BOOM PULLEYS
58						BOOM
59						WATER TANK (TOP)
60						WATER TANK (TOP)
61						PUMP SUCTION HOSE
62						EXHAUST STACK
63						BOOM
64						SPARE TIRE RACK
65						SPARE TIRE
66						BATTERY BOX

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
67				<143		STEAM CLEANER
68						STEAM CLEANER
69						STEAM CLEANER
70						PUMP
71						PUMP
72						PUMP GLAND
73						BOOM
74						BOOM
75						BOOM UPPER HYDRAULIC SLIDE
76						HYDRAULIC RESEVOIR
77						HYDRAULIC RESEVOIR
78						BOOM
79						BOOM
80						BOOM
81						DRILL HEAD
82						DRILL HEAD COUPLING
83						DRILL HEAD TRANSMISSION
84						DRILL HEAD TRANSMISSION GEARSHIFT
85						BOOM
86						BOOM LOWER HYDRAULIC SLIDE
87						SPEED WINCH
88						BOOM BASE
89						AUGER FORK
90						DUECE ROD
91						SPOON HEAD
92						SPLIT SPOON

N.D. - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA.

MAP ID: NONE

COMMENTS: RELEASE SURVEY OF GEO-LOGIC DRILL RIG

SURVEYOR: S. JOHNSON

DATE: 20 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
93				<143		AUGER PLUG
94						140# HAMMER
95						LEAD AUGER HEAD (INSIDE)
96						LEAD AUGER
97						2ND AUGER
98						3RD AUGER
99						5FT ROD
100						5FT ROD
101						DUECE/3FT ROD
102						AUGER RACK
103						AUGER RACK
104						AUGER RACK
105						REAR LICENSE PLATE
106						RIGHT TAILLIGHT
107						FRONT OF RIGHT MUDFLAP
108						BACK OF RIGHT MUDFLAP
109						RIGHT JACK
110						RIGHT JACK
111						LEFT JACK
112						LEFT JACK
113						BACK OF LEFT MUDFLAP
114						FRONT OF LEFT MUDFLAP
115						LEFT FRONT FENDERWELL
116						FRONT JACK
117						FRONT JACK
118						RIGHT FRONT FENDERWELL

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ☒ NEUTRON ☐ micro R/hr ☒	ITEM OR LOCATION
119				<143		RIGHT SIDE OF FRONT AXLE
120						RIGHT FRONT WHEEL (INSIDE)
121						FRONT AXLE
122						RIGHT LEAF SPRING
123						LEFT FRONT AXLE
124						LEFT FRONT WHEEL (INSIDE)
125						STEERING ROD
126						OIL PAN
127						FRAME
128						MUFFLER
129						BOTTOM OF LEFT TOOL BOX
130						TRUCK TRANSMISSION
131						PTO
132						PTO SHAFT
133						BOTTOM OF RIGHT TOOL BOX
134						FRAME
135						DRIVE SHAFT (1ST SEGMENT)
136						DRIVE SHAFT (2ND SEGMENT)
137						FRAME
138						REAR AXLE (LEFT FRONT)
139						INNER LEFT REAR WHEEL ON INSIDE
140						ELECTRIC REAR END
M1						REAREND
M2						REAR AXLE (RIGHT FRONT)
143						INNER RIGHT REAR WHEEL ON INSIDE
144						REAR AXLE (RIGHT REAR)

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN/WATERTOWN, MA

MAP ID: NONE

PAGE 4 OF 4

COMMENTS: RELEASE SURVEY OF GEOLOGIC DRILL RIG

SURVEYOR: S. JOHNSON

DATE: 20 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/PROBE NO	ALPHA EQUIV ___ dpm/PROBE	ALPHA EQUIV ___ dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
145				<143		INNER RIGHT REAR WHEEL ON OUTSIDE
146						OUTER RIGHT REAR WHEEL ON INSIDE
147						REAR END
148						REAR AXLE (LEFT REAR)
149						INNER LEFT REAR WHEEL ON OUTSIDE
150						OUTER LEFT REAR WHEEL ON INSIDE
151						FRAME
152						FRAME CROSSMEMBER

SWIPE/PROBE NO	ALPHA EQUIV. ___ dpm/PROBE	ALPHA EQUIV. ___ dpm/100 cm²	BETA-GAMMA EQUIV. ___ dpm/PROBE	BETA-GAMMA EQUIV. ___ dpm/100 cm	mrem/hr. ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

21 JUL 90

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 22 JUL 90 | TIME START: 1510 | TIME COMPL: 1600 | PAGE 1 OF 3

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP I.D.: 7-22-01

DAILY ☐ WEEKLY ■ MONTHLY ■ CONTAMINATION AND DAILY ☐ WEEKLY ■ MONTHLY ■ RADIATION SURVEY

COMMENTS: MONTHLY SURVEY OF AREAS OF NON-RAM STORAGE
WEEKLY SURVEY OF RAM STOWAGE AREA

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; <1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	—
SOURCE STRENGTH	dpm	11371 dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	2465 cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR		0.21 / 4.36	—
MDA	dpm	143 dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	35 cpm	6.5 μR/hr ~~mR/hr.~~

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA ESP-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-2 #803

RADCON REVIEW: Scott A. [illegible] DATE: 29 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO. ☐ SPECIAL ■ ROUTINE SEE COMMENTS

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA EQUIV — dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA EQUIV U-238 dpm/100 cm	mrem/hr. ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1			<143		7.2	LOCATION SHOWN ON
2					7.0	MAP 7-22-01
3					7.2	
4					7.1	
5					7.3	
6					7.5	
7					7.3	
8					7.0	
9					6.9	
10					6.8	
11					6.8	
12					7.0	
13					7.0	
14					7.3	
15					7.2	
16					7.0	
17					6.9	
18			<143		7.4	MAP 7-22-01
19					7.3	
20					7.0	
21					6.8	
22					7.2	
23					5.2	
24					4.3	
25					5.5	
26					4.5	
27					4.5	
28					4.3	
29					4.3	
30					4.7	
31					4.4	
32					5.0	
33					7.2	
34					7.2	
35					6.7	
36					6.2	
37					6.7	
38					6.0	
39					6.0	
40					6.2	

* THE KNOWING & WILLFUL [illegible]DING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUN[illegible] AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS INC

CONTAMINATION/RADIATION SURVEY REPORT
CONTINUATION SHEET

TO: PROJECT FILE

ACTIVITY/LOCATION: GSA-WATERTOWN/ WATERTOWN, MA

MAP ID: 7-22-01

PAGE 2 OF 3

COMMENTS: MONTHLY SURVEY OF AREAS OF NON-RAM STORAGE
WEEKLY SURVEY OF RAM STORAGE AREA

SURVEYOR: S. JOHNSON

DATE: 22 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

SWIPE/ PROBE NO	ALPHA EQUIV ___ dpm/ PROBE	ALPHA EQUIV ___ dpm/ 100 cm²	BETA-GAMMA EQUIV U-238 dpm/ PROBE	BETA-GAMMA EQUIV U-238 dpm/ 100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
41				<143	6.0	MAP 7-22-01
42					6.2	
43					6.2	
44					6.3	
45					6.5	
46					6.5	
47					7.3	

SWIPE/ PROBE NO	ALPHA EQUIV. ___ dpm/ PROBE	ALPHA EQUIV. ___ dpm/ 100 cm²	BETA-GAMMA EQUIV ___ dpm/ PROBE	BETA-GAMMA EQUIV ___ dpm/ 100 cm	mrem/hr. ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr. ☐	ITEM OR LOCATION

NO - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS, INC

Radiation/Contamination Survey Grid Map

PROJECT FILE

COMMENTS: MONTHLY SURVEY OF AREAS OF NON-RAM STORAGE.
WEEKLY SURVEY OF RAM STORAGE AREA

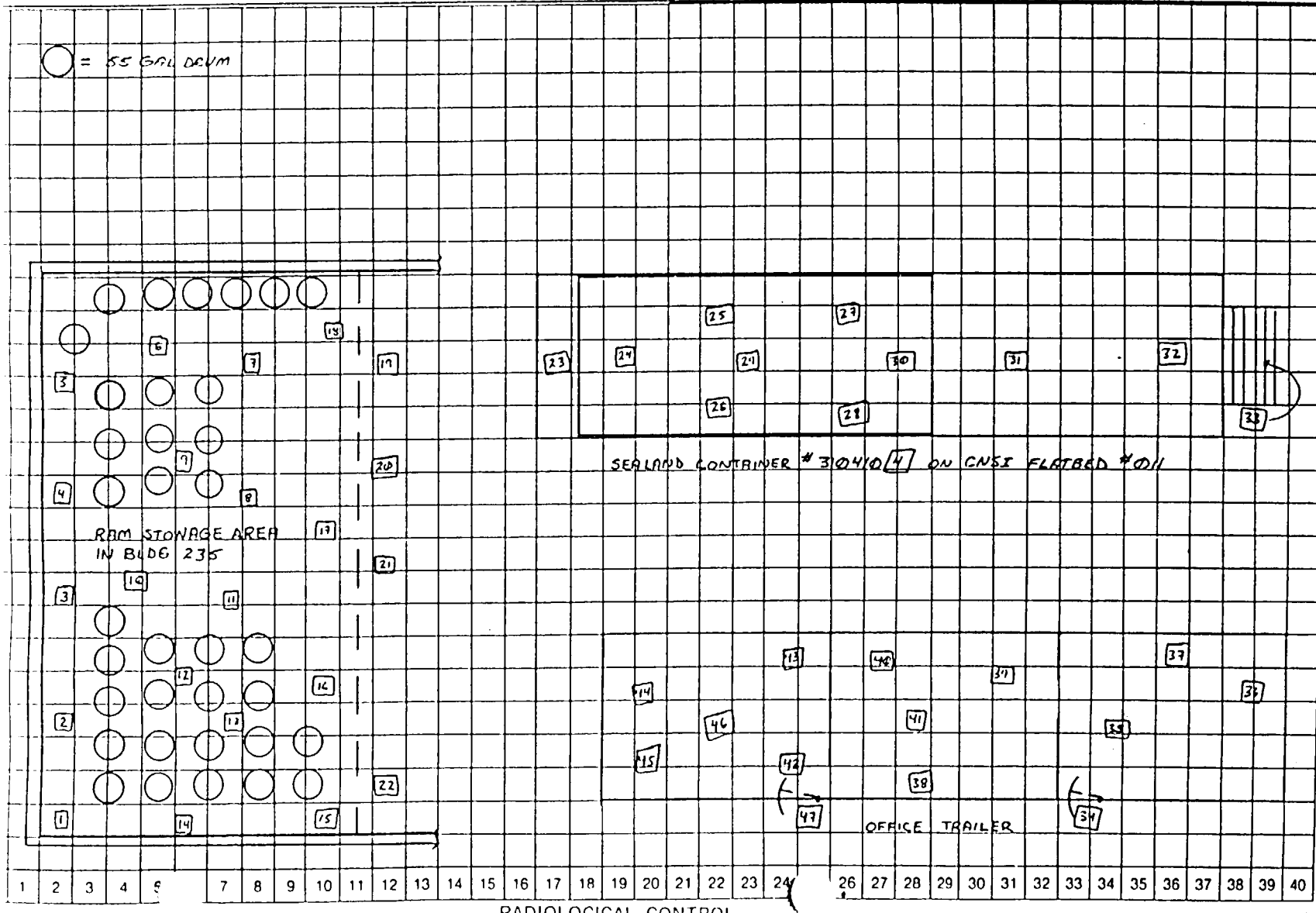
ACTIVITY/LOCATION: GSA-WATERTOWN / WATERTOWN, MA

SURVEYOR: S. JOHNSON

PAGE 3 3

DATE: 22 JUL 90

NOTE: THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.



RADIOLOGICAL CONTROL

ID NUMBER -01

S. 1/4" =

CHEM-NUCLEAR SYSTEMS, INC

CONTAMINATION / RADIATION SURVEY REPORT

TO: PROJECT FILE

DATE: 23 JUL 90 | TIME START: 1405 | TIME COMPL: 1410 | PAGE 1 / 1

ACTIVITY/LOCATION: GSA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S. JOHNSON | PHONE: —

MAP ID: NONE

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ☐ RADIATION SURVEY

COMMENTS: SURVEY OF BOBCAT USED FOR DRUM MOVING

PERMISSIBLE LEVELS: — dpm/100 cm² ALPHA; 1000 dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D.

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I.D.		U-238	
SOURCE STRENGTH	dpm	11771 dpm	mR/hr
INSTRUMENT RESPONSE	cpm	2497 cpm	mR/hr
EFFICIENCY/CORRECTION FACTOR		0.21/4.76	
BGA	dpm	138 dpm	SAT ☑ UNSAT ☐
BACKGROUND	cpm	33 cpm	mR/hr

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —		BETA-GAMMA E3P-1 #1116
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —		BETA-GAMMA —

RADCON REVIEW [signature] DATE 27 JUL 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ____ ■ SPECIAL RETURN BOBCAT TO VENDOR ☐ ROUTINE ____

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV U-238 dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION
1			33 SS	< 138		DRIVERS SEAT
2						CAB SAFETY BAR
3						CAB FLOOR
4						LEFT FRONT FORK
5						LEFT FRONT DRUM CLAMP
6						RIGHT FRONT DRUM CLAMP
7						RIGHT FRONT FORK
8						RIGHT FRONT WHEEL
9						RIGHT WHEEL (REAR)
10						REAR SKIP (BOTTOM)
11						LEFT REAR WHEEL
12						LEFT FRONT WHEEL
13						FRONT AXLE
14						UNDER ~~CARRIGE~~ CARRIGE
15						UNDER ~~CARRIGE~~ CARRIGE
16						AXLE (REAR)
17						

SWIPE/PROBE NO	ALPHA EQUIV — dpm/PROBE	ALPHA dpm/100 cm²	BETA-GAMMA EQUIV — dpm/PROBE	BETA-GAMMA dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
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40						

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

CHEM-NUCLEAR SYSTEMS INC

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

24 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

25 JUL 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

26 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

27 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

23 JUL 90

CHEM-NUCLEAR SYSTEMS INC

NO
SURVEYS
THIS
DATE

29 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

30 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

31 JUL 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

01 AUG 90

CHEM-NUCLEAR SYSTEMS, INC

NO
SURVEYS
THIS
DATE

02 AUG 90

CONTAMINA /RADIATION SURVEY REPORT

TO: PROJECT FILES

DATE: 03 AUG 90 | TIME START: 0830 | TIME COMPL: 1230 | PAGE 1 OF 2

ACTIVITY/LOCATION: GTA-WATERTOWN, WATERTOWN, MA

SURVEYOR: S JOHNSON | PHONE: —

MAP ID: 8-03-01

DAILY ☐ WEEKLY ☐ MONTHLY ☐ CONTAMINATION AND DAILY ☐ WEEKLY ☐ MONTHLY ☐ ■ RADIATION SURVEY

COMMENTS: FINAL SURVEY PRIOR TO SECURING OPERATIONS.

PERMISSIBLE LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

CSCA AREA CONTROL LEVELS: N/A dpm/100 cm² ALPHA; N/A dpm/100 cm² BETA-GAMMA

☐ OTHER (SEE COMMENTS) ■ NO ACTION REQ'D

SOURCE CHECK DATA	CONTAMINATION SURVEYS ALPHA	CONTAMINATION SURVEYS BETA/GAMMA	RADIATION BETA/GAMMA
SOURCE I D			—
SOURCE STRENGTH	dpm	dpm	— mR/hr.
INSTRUMENT RESPONSE	cpm	cpm	— mR/hr.
EFFICIENCY/CORRECTION FACTOR			—
MDA	dpm	dpm	SAT. ■ UNSAT. ☐
BACKGROUND	cpm	cpm	7.0 μR mR/hr.

CONTAMINATION SURVEY INSTRUMENT TYPE/TAG NO	ALPHA —	BETA-GAMMA —
RADIATION SURVEY INSTRUMENT TYPE/TAG NO	NEUTRON —	BETA-GAMMA ESP-1 #1116

RADCON REVIEW: [signature] DATE 03 AUG 90

REASON FOR SURVEY: ☐ PROCEDURE—NO ____ ■ SPECIAL FINAL WALKOVER OF SITE ☐ ROUTINE ____

SWIPE PROBE NO	ALPHA EQUIV dpm/PROBE	ALPHA EQUIV dpm/100 cm²	BETA-GAMMA EQUIV dpm/PROBE	BETA-GAMMA EQUIV dpm/100 cm	mrem/hr ☐ ~~BETA~~-GAMMA ■ NEUTRON ☐ micro R/hr ■	ITEM OR LOCATION
1					LEVEL AND CORRESPONDING LOCATION	
2					SHOWN ON MAP 8-03-01	
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

SWIPE PROBE NO	ALPHA EQUIV dpm/PROBE	ALPHA EQUIV dpm/100 cm²	BETA-GAMMA EQUIV dpm/PROBE	BETA-GAMMA EQUIV dpm/100 cm	mrem/hr ☐ BETA-GAMMA ☐ NEUTRON ☐ micro R/hr ☐	ITEM OR LOCATION
18						
19						
20						
21						
22						
23						
24						
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27						
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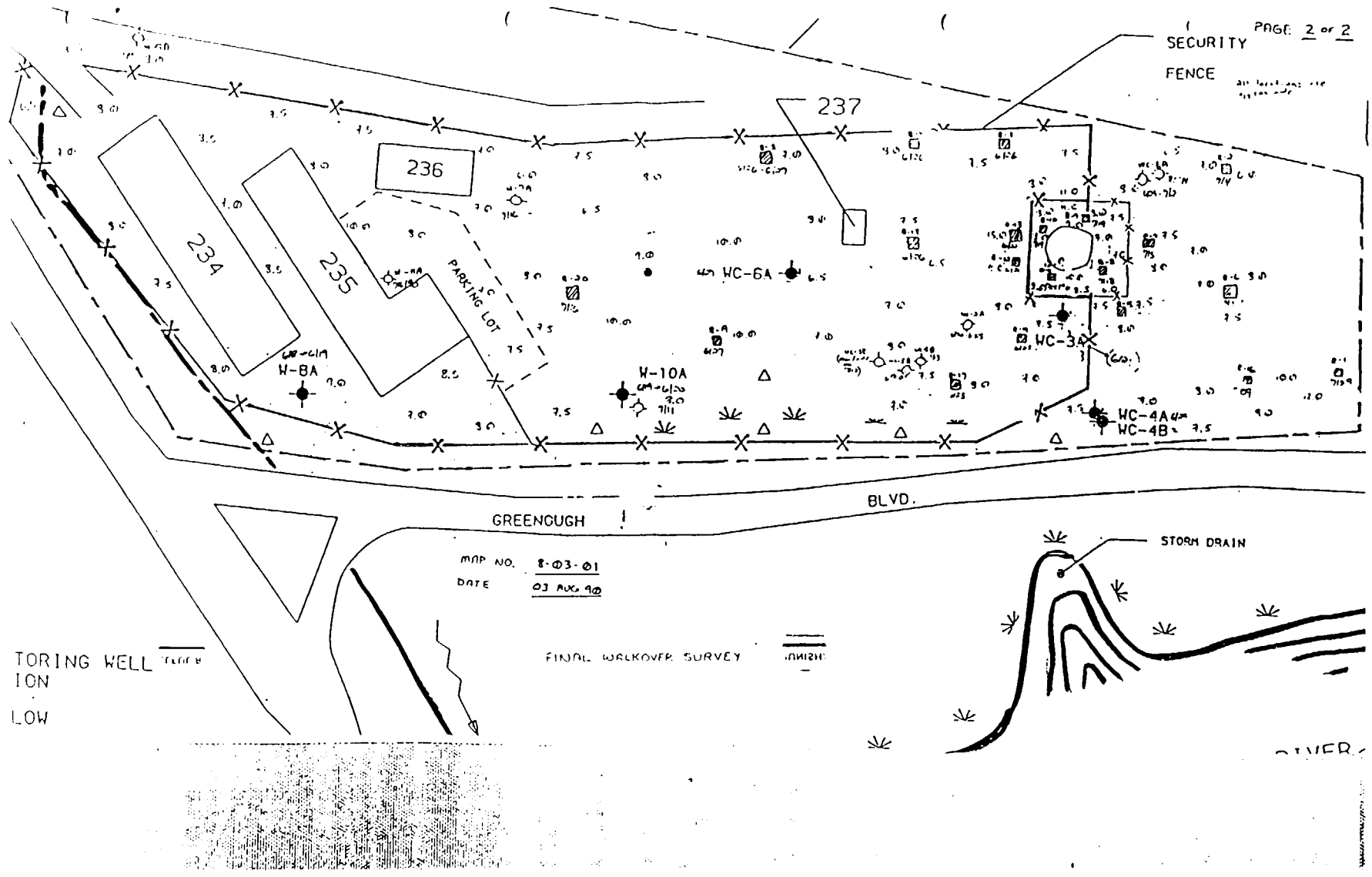
40						

* THE KNOWING & WIL ECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE P BLE AS A FELONY UNDER FEDERAL STATUTES

ND - Not Detectable

RADIOLOGICAL CONTROL

CHEM-NUCLEAR SYSTEMS INC



CHEM-NUCLEAR SYSTEMS, INC

CHEM-NUCLEAR SYSTEMS, INC.
Corporate Office
140 Stoneridge Drive
Columbia, South Carolina 29210
(803) 256-0450

Northern Office
302 W. Main Street, Suite 204
Avon, Connecticut 06001
(203) 677-0457

Midwest Office
P.O. Box 293
Channahon, Illinois 60410
(815) 467-3000

Barnwell Operations
P.O. Box 726
Barnwell, South Carolina 29812
(803) 259-1781

Defense Consolidation Facility
P.O. Box 828
Barnwell, South Carolina 29812
(803) 259-1119

GENERAL NUCLEAR SYSTEMS, INC. (GNSI)
A Chem-Nuclear Company
140 Stoneridge Drive
Columbia, South Carolina 29210
(803) 256-0450

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-8A
Sample Type: Water

CHAS Lab #: 9007219-02W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	0.27 +/- 0.05	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-9A
Sample Type: Water

CHAS Lab #: 9007219-03W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	0.27 +/- 0.05	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-11A
Sample Type: Water

CHAS Lab #: 9007219-04W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-7A
Sample Type: Water

CHAS Lab #: 9007219-06W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	0.27 +/- 0.05	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: WC-10B
Sample Type: Water

CHAS Lab #: 9007219-07W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: WC-10A
Sample Type: Water

CHAS Lab #: 9007219-08W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-6A
Sample Type: Water

CHAS Lab #: 9007219-09W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: WC-5A
Sample Type: Water

CHAS Lab #: 9007219-10W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: WC-5C
Sample Type: Water

CHAS Lab #: 9007219-11W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-11A
Sample Type: Water

CHAS Lab #: 9007219-04W
Date Received: 07/27/90

DUPLICATE AND SPIKE ANALYSIS

Parameter	MDL	Original Result*	Duplicate Result*	RPD (%)	Spike Result*	Recovery (%)
Uranium	---	LT 0.14	LT 0.14	0	2.3 ± 0.5	95.8

Notes: ND = Below minimum detectable level (MDL)
* = pCi/g
Soil/solid samples based on sample dry weight.

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-2A
Sample Type: Water

CHAS Lab #: 9007220-01W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-3A
Sample Type: Water

CHAS Lab #: 9007220-02W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-1A
Sample Type: Water

CHAS Lab #: 9007220-03W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-1B
Sample Type: Water

CHAS Lab #: 9007220-04W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	0.34 +/- 0.07	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-4A
Sample Type: Water

CHAS Lab #: 9007220-05W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-4B
Sample Type: Water

CHAS Lab #: 9007220-06W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-1 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-07W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.3	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-1 / WATER
Sample Type: Water

CHAS Lab #: 9007220-08W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-2 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-10W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.3	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-2 / WATER
Sample Type: Water

CHAS Lab #: 9007220-11W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	0.27 +/- 0.05	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-3 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-12W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.3	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-3 / WATER
Sample Type: Water

CHAS Lab #: 9007220-13W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-4 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-14W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.3	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: M-4 / WATER
Sample Type: Water

CHAS Lab #: 9007220-15W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: DS-1 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-16W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.3	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: DS-1 / WATER
Sample Type: Water

CHAS Lab #: 9007220-17W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: US-1 / SOIL
Sample Type: Soil

CHAS Lab #: 9007220-18W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	7.5 +/- 1.5	pCi/g	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

CleanHarbors

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: US-1 / WATER
Sample Type: Water

CHAS Lab #: 9007220-19W
Date Received: 07/27/90

Parameter	Result*	Units	Analysis Date	Method Number and Reference
Uranium	LT 0.14	pCi/l	08/17/90	908.1(h)

Notes: * Error = 2 standard deviations
LT = Less than 2 standard deviations in the net count rate or the procedure detection limit

Client: Chem-Nuclear Systems, Inc.
Sample I.D.: W-4A
Sample Type: Water

CHAS Lab #: 9007220-05W
Date Received: 07/27/90

DUPLICATE AND SPIKE ANALYSIS

Parameter	MDL	Original Result*	Duplicate Result*	RPD (%)	Spike Result*	Recovery (%)
Uranium	---	LT 0.14	LT 0.14	0	2.2 ± 0.4	91.7

Notes: ND - Below minimum detectable level (MDL)
* - pCi/g
Soil/solid samples based on sample dry weight.

APPENDIX E
MORRISON KNUDSEN & SCIENTIFIC ECOLOGY GROUP (MS & SEG) DATA

APPENDIX C

Tables detailing summary tables and fraction of limit tables from the termination and characterization survey results are provided in Appendix C. Following is an index listing the tables and figures by area surveyed.

Note: Figures for Building 653, pumphouse are included in Appendix F. Burn pit soil bore logs are in Appendix D.

Off-Site Surveys

Off-Site Background Soil Sample Locations	Figure C-1
Off-Site Background Exposure Rate at 1 Meter	Table C-1
Off-Site Background Soil Samples Gamma Spectrum Analyses Results	Table C-2

Entire Site Surveys

15 x 15 Meter Grid at GSA and Property 20 Sites	Figure C-2
Random Soil Sample Locations	Figure C-3
GSA Site Random Soil Sample Survey Gamma Spectrum Analyses	Table C-3
Gamma Exposure Rate Measurements	Table C-4

Building Surveys - 1993

Direct Beta Survey Statistics	Figure C-4 to C-12
Gamma Survey Statistics	Figure C-13 to C-19

Building Surveys - 1994

Direct Beta Survey Statistics	Figure C-20 to C-21
Gamma Survey Statistics	Figure C-22

Characterization Survey Results - Summary Tables, Fraction of Limit Tables

Burn Pit

Soil boring Locations, 1993, 1994, Including wells	Figure C-23
Soil Bore Samples Gamma Spectroscopy Analyses Results	Table C-5
Locations for In Situ Measurements and Soil Samples	Figure C-24
Surface Soil Samples Gamma Spectroscopy Sample Analyses Results	Table C-6
Bulk Soil Sample Gamma Spectroscopy Sample Analyses Results	Table C-7
In Situ Gamma Spectroscopy Results Fraction of Limit	Table C-8

Clinker Area

Locations of In Situ and Soil Samples in the Burn Pit and Clinker Areas	Figure C-25
Surface Soil Samples Gamma Spectroscopy Sample Analyses Results	Table C-9
In Situ Gamma Spectroscopy Results Fraction of Limit	Table C-10

Boundary
Zones for In Situ Boundary Survey — Figure C-26
In Situ Gamma Spectroscopy Survey - Northeast — Table C-11
In Situ Gamma Spectroscopy Survey - Northwest — Table C-12
In Situ Gamma Spectroscopy Survey - Southeast — Table C-13
In Situ Gamma Spectroscopy Survey - Southwest — Table C-14

Windborne
Soil Samples Gamma Spectroscopy Sample Analyses — Table C-15

Property 20
Locations of In Situ Measurements and Soil Samples in Property 20 — Figure C-27
Surface Soil Samples Gamma Spectroscopy Sample Analyses Results — Table C-16
In Situ Gamma Spectroscopy Results — Table C-17

Characterization Survey Results - Detail Tables
Soil Sample Locations and Descriptors — Table C-18

Burn Pit
Soil Boring Locations, 1993, 1994, Including wells — Figure C-28
Core Bore Sample Analysis Results — Table C-19
Comparison of Total Uranium and Gamma Spectroscopy Analysis Data — Table C-20
Burn Pit Locations for In Situ measurements and Soil Samples — Figure C-29
Surface Soil Samples Gamma Spectroscopy Analyses Results — Table C-21
In Situ Gamma Spectroscopy Analysis Results — Table C-22
Burn Pit Soil Sample Density and Moisture Content — Table C-23
The GSA Burn Pit are Showing Locations of Flags Placed During the Scan for DU Chips and the Areas Where Scraping Was Done — Figure C-30
Bulk Soil Samples Gamma Spectroscopy Sample Analyses Results — Table C-24
Scanning for DU Chips in Scraped Areas — Figure C-31 to C-34

Clinker Area
Locations of In Situ and Soil Samples in the Burn Pit and Clinker Areas — Figure C-35
Surface Soil Samples Gamma Spectroscopy Sample Analyses Results — Table C-25
In Situ Gamma Spectroscopy Results — Table C-26

Boundary
Zones for In Situ Boundary Survey — Figure C-36
In Situ Gamma Spectroscopy — Table C-27 to C-30

Windborne
Location Selected for Sampling for Windborne Deposition of Depleted Uranium — Figure C-37
Surface and Subsurface Soil Samples Gamma Spectroscopy Sample Analyses Results — Table C-36

Property 20
Locations of In Situ and Soil Sample Measurements — Figure C-38
Surface Soil Samples Gamma Spectroscopy Sample Analyses Results — Table C-32
In Situ Gamma Spectroscopy Sample Analyses Results — Table C-33
Property 20 Soil Sample Density and Moisture Content — Table C-34

Other
GSA Soil from Woods North of Perimeter Fence Gamma Spectrum Analyses — Table C-35

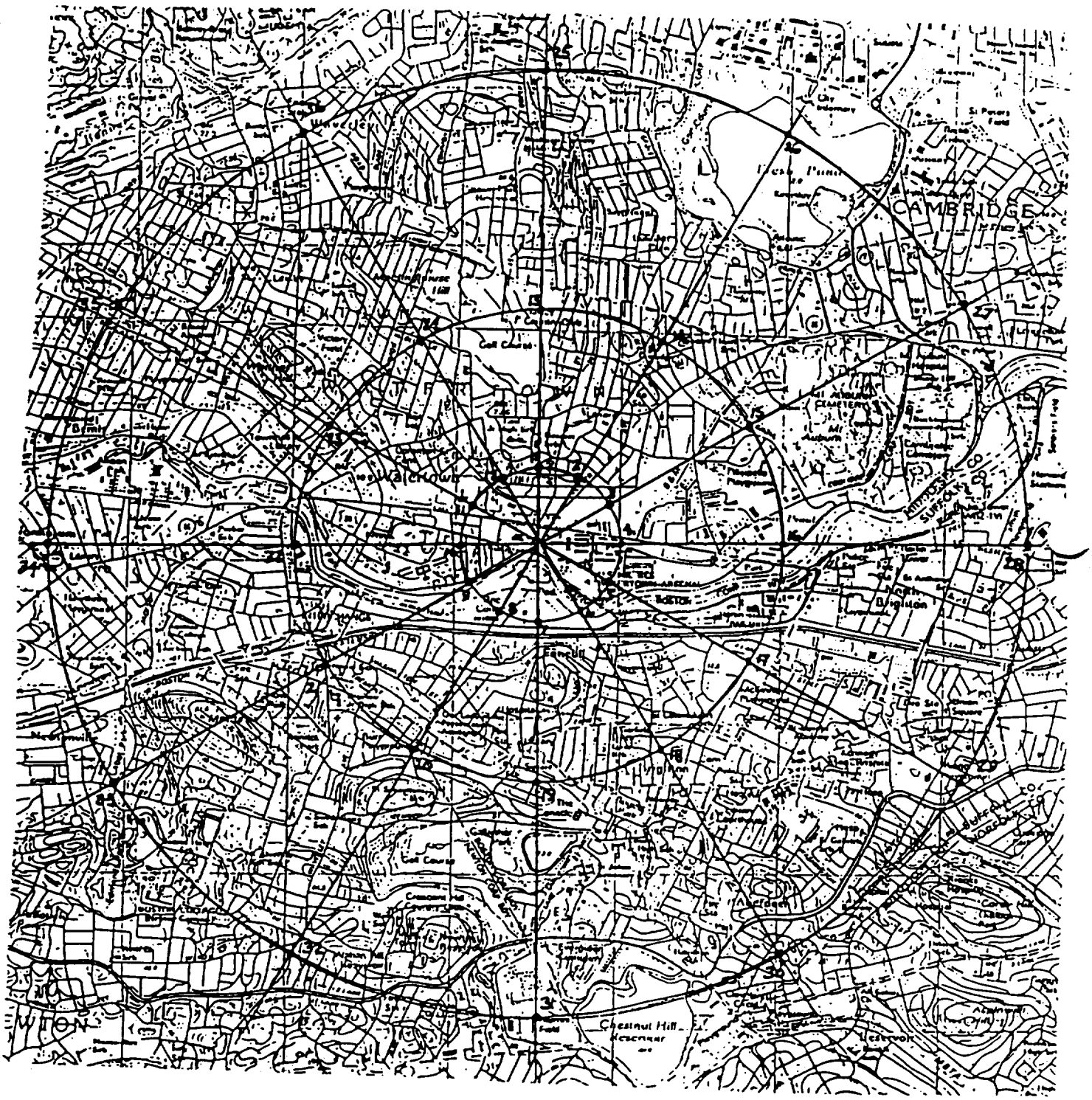


Figure C-1
Off-Site Background Soil Sample Locations

Table C-1
Off-Site Background Exposure Rate At 1 Meter (μR/hr)

Location Code	Location Description	Mean	Std Dev	Number of Measurements
P05000	0.5 km North, 14 Hosmer, Watertow Watertown (city property)	10.6	0.8	21
P05030	0.5 km NNE, 18 Putnam, Watertown	12.7	0	1
P05060	0.5 km ENE, Quimby/Cypress intersection, Watertown (city prop.)	12.9	1	20
P05090	0.5 km West, NE Corner AMTL	13.4	0.5	20
P05120	0.5 km ESE, Arsenal Park, Watertown	12.8	0	1
P05150	0.5 km SSE, 46 Newton, Newton (city property)	10.8	0.8	20
P05180	0.5 km South, East of MDC Field on Charlesbank, Newton	13	1.2	21
P05210	0.5 km SSW, MDC Skating Rink on Charlesbank, Newton	13.2	0.8	21
P05240	0.5 km WSW, 328 Charlesbank Rd., Watertown (city property)	11.4	0.7	20
P05270	0.5 km West, 96 Beechwood, Watertown (city property)	12.8	0.6	20
P05300	0.5 km WNW, 30 Frank, Watertown (city property)	12.2	1.2	18
P05330	0.5 km NNW, 136 Walnut St., Watertown	14.7	1.6	21
P15000	1.5 km North, 29 Commonwealth Ave, Watertown (city property)	11.7	0.4	20
P15030	1.5 km NNE, 56 Salisbury, Watertown (city property)	9.5	0.5	20
P15060	1.5 km ENE, 133 Grove, Watertown (city propert)	11.5	0.7	40
P15090	1.5 km West, Old Arsenal Greenough Blvd., Watertown	11	1	40
P15120	1.5 km ESE, 117 Murdock, Boston	11.4	0.7	20
P15150	1.5 km SSE, Peters Park., Boston	9.5	0.4	20
P15180	1.5 km South, Hareman Park, Boston	10.4	0.6	20
P15210	1.5 km SSW, 15 Nonantum, Newton	12.4	0.3	20
P15240	1.5 km WSW, 8 Eldridge St., Newton (city property)	13.1	0.8	20
P15270	1.5 km West, 66 Capital, Newton (city property)	12.2	0.6	19
P15300	1.5 km WNW, 91 Church St., Watertown	9.9	1.2	39
P15330	1.5 km NNW, 119 Robbins, Watertown	12.9	0.4	19
P30000	3 km North, 22 Bow Rd., Belmont (city property)	9.7	1.3	21
P30030	3 km NNE, 17 Bright, Belmont (city property)	11.3	1	21
P30060	3 km ENE, 157 Brattle St., Cambridge (city property)	10.9	0.8	20
P30090	3 km East, 7 Rena St., Boston	11.8	0.5	20
P30120	3 km ESE, across 1302 Commonwealth Ave, Boston (city property)	13.3	0.7	20
P30150	3 km SSE, MDC Pool and Park, Boston	12.3	0.6	20
P30180	3 km South, Boston College Football Field, Newton	13.8	1	41
P30210	3 km SSW, 286 Ward St., Newton	11.4	1	39
P30240	3 km WSW, Cabot Park, Newton	11.6	0.8	40
P30270	3 km West, 103 Bridge, Watertown	13.5	0.7	20
P30300	3 km WNW, 103 Chapman, Watertown (city property)	13.4	0.6	20
P30330	3 km NNW, 91 Waverly, Belmont (city property)	11.3	0.7	20

Table C-2
Off-Site Background Soil Samples
Gamma Spectrum Analyses Results (pCi/g)

Location	K-40	Co-137	Tl-208	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234
P05000	13.5	1.2	0.3	3.0	0.4	0.7	0.6	0.6		1.8	0.6	
P05030	13.9	0.6	0.3	1.9	0.6	0.9	0.7	0.7	0.7	2.2	0.8	0.6
P05060	14.6	1.9	0.3		0.6	0.1	0.6	0.6	0.8	2.1	0.8	1.2
P05090	14.3	0.2	0.3	2.3	0.6	0.9	0.7	0.7	0.8	2.2	0.8	0.8
P05210	17.5	0.1	0.2			0.5	0.4	0.4		1.1	0.5	
P05150	15.9	0.4	0.3		0.3	0.7	0.5	0.5	0.5	1.2	0.7	0.7
P05180	16.6	0.2	0.3			0.7	0.5	0.5	0.8		0.7	
P05210	19.4	0.1	0.3	1.5	0.6	0.8	0.6	0.6		1.7	0.8	1.2
P05240	15.6	0.1	0.3		0.4	0.9	0.6	0.7		1.8	0.7	1.2
P05270	21.9	0.1	0.4		0.6	1.2	0.8	0.9	0.9	2.5	1.0	1.7
P05300	15.4	0.3	0.3		0.4	0.8	0.6	0.6	0.4	2.2	0.7	
P05330	17.7	0.1	0.3	1.9	0.3	1.0	0.7	0.7	0.6	1.7	0.9	0.8
P15000	14.9	1.0	0.3		0.5	0.7	0.7	0.7		2.0	0.8	
P15030	14.0	0.2	0.3	2.0	0.4	0.7	0.5	0.6	0.6	1.8	0.7	0.3
P15060	15.5	0.2	0.2	2.3		0.6	0.5	0.5		1.4	0.6	0.9
P15090	15.8	0.3	0.3			0.7	0.6	0.6		1.5	0.7	
P15120	16.5	0.0	0.3		0.5	0.8	0.7	0.7		2.1	0.8	1.1
P15150	13.5	0.4	0.3	2.6	0.6	1.1	0.7	0.7		2.1	0.8	
P15180	15.5	0.3	0.3	2.1	0.4	0.9	0.6	0.6	0.5	1.9	0.7	
P15210	16.9	0.4	0.3		0.5	0.9	0.6	0.6		1.7	0.9	1.0
P15240	15.3	0.4	0.3	4.0	0.5	0.8	0.5	0.6	0.5	1.6	0.7	0.6
P15270	14.6	0.5	0.3		0.5	0.8	0.6	0.6	0.6	1.3	0.7	1.0
P15300	13.9	0.4	0.3	2.2	0.6	0.9	0.6	0.7	0.6	2.0	0.7	1.0
P15330	19.5	0.5	0.4	3.2	0.9	1.4	1.1	1.2	0.8	3.2	1.2	1.1
P30000	15.1	0.3	0.3	1.6	0.4	0.7	0.5	0.6	0.6	1.6	0.7	0.7
P30030	14.9	1.1	0.3	2.6	0.5	0.6	0.6	0.7		2.1	0.7	0.8
P30060	14.7	0.3	0.3		0.3	0.9	0.6	0.6		1.4	0.7	1.2
P15120	15.4	0.5	0.4		0.6	1.1	1.0	1.0	0.8	2.0	1.0	1.7
P30120	15.9	0.4	0.3		0.5	1.0	0.7	0.7	0.5	1.9	0.8	1.2
P30150	15.2	0.6	0.3		0.4	0.7	0.7	0.7	0.7	2.2	0.8	
P30180	16.1	0.2	0.3		0.7	0.9	0.7	0.7	0.9	2.1	0.8	0.5
P30210	13.0	0.4	0.3	1.9	0.4	0.8	0.6	0.6	0.8	2.2	0.7	1.1
P30240	16.2	0.5	0.2	1.3	0.4	0.7	0.6	0.6	0.6	1.5	0.6	
P30270	16.3	0.4	0.4	2.3	0.7	1.1	0.9	0.9	0.8	2.2	0.9	1.1
P30300	17.8	0.6	0.3	2.4	0.5	0.9	0.7	0.8	0.6	1.9	0.9	0.7
P30330	15.0	0.2	0.3	2.4	0.2	0.6	0.5	0.5		1.6	0.6	0.9
Mean	15.8	0.4	0.3	2.3	0.5	0.8	0.6	0.7	0.7	1.9	0.8	1.0
Std. Deviation	1.8	0.4	0.1	0.6	0.1	0.2	0.1	0.2	0.1	0.4	0.1	0.3
Mean + 3S	21.2	1.5	0.4	4.2	0.9	1.5	1.0	1.1	1.1	3.1	1.2	1.9

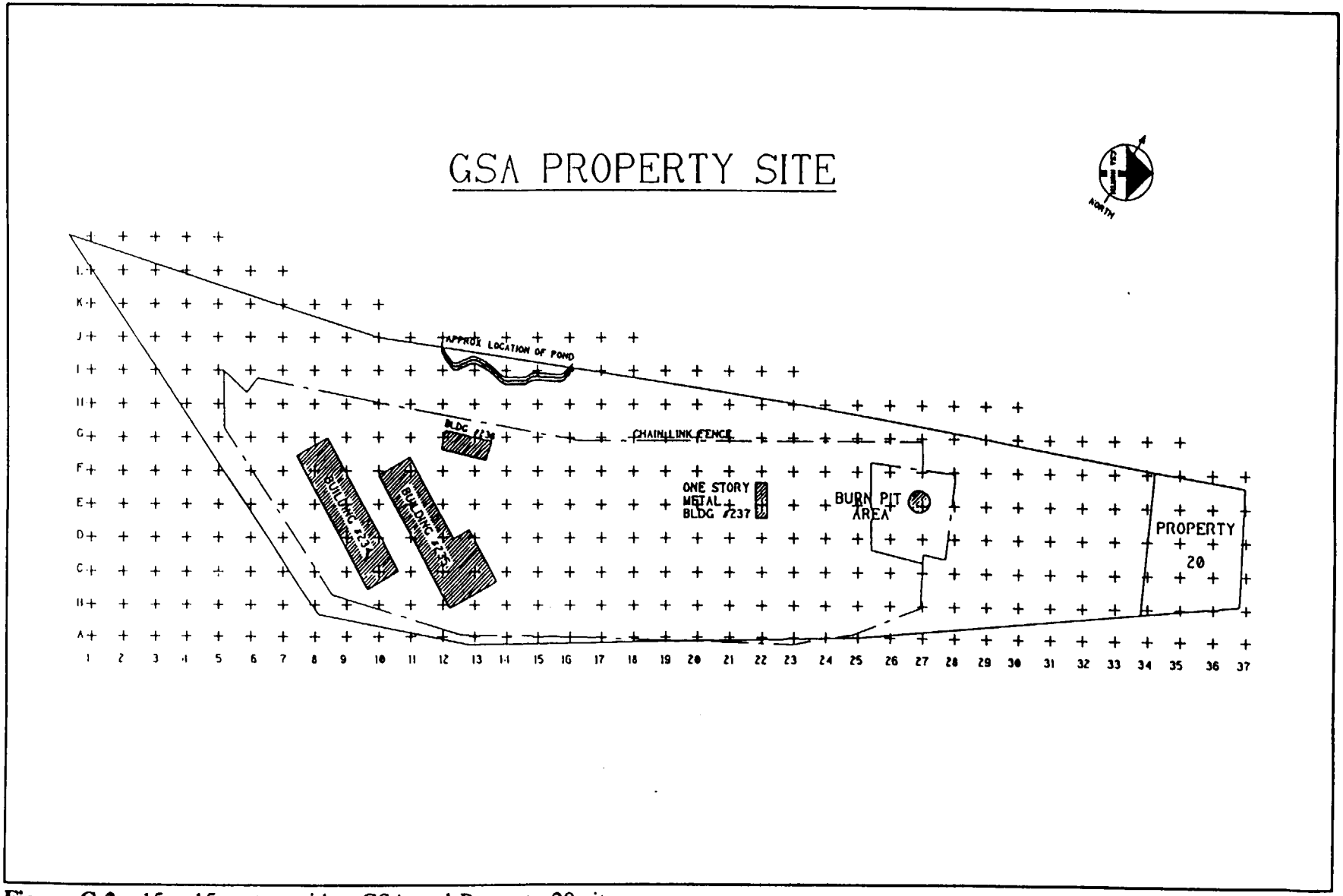


Figure C-2. 15 x 15 meter grid at GSA and Property 20 sites

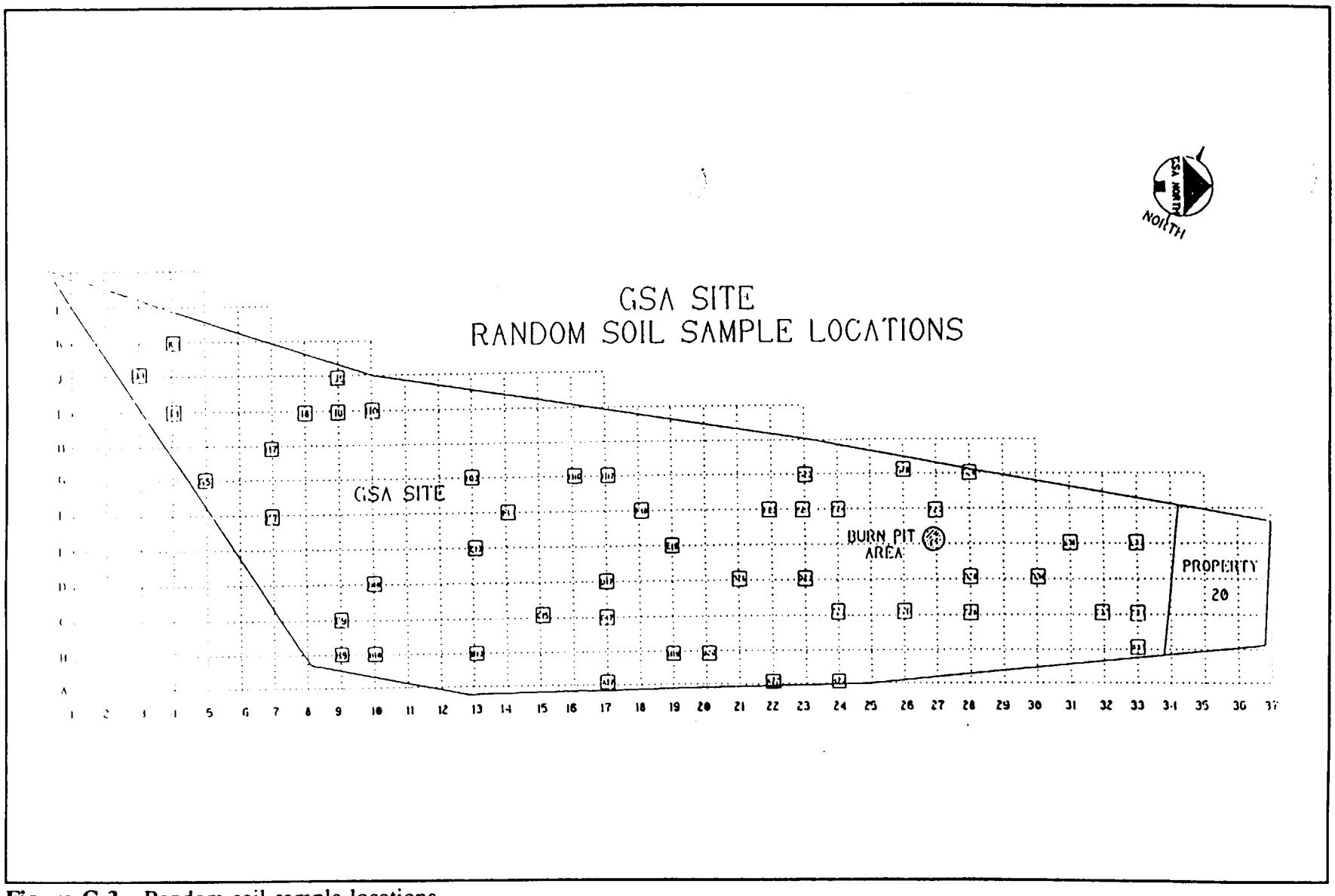


Figure C-3. Random soil sample locations

Table C-3
GSA Site Random Soil Sample Survey
Gamma Spectrum Analyses (pCi/g)

Location	Grid	K-40	Cs-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234
surface	A-17		1.5			0.3	0.8	0.8				
sub-surf	A-17	20.7		0.3		0.7	0.6	0.8			0.8	
surface	A-22	7.9	1.5	0.2		0.5	1.0	0.9				
sub-surf	A-22	9.4		0.3		0.7	0.8	0.8			0.9	
surface	A-24	12.4	0.6	0.4		0.9	1.5*	1.3*				
sub-surf	A-24	9.9		0.3		0.7	0.1	1.1			0.9	
surface	B-09	15.7	1.3			0.5	0.6	0.6				
sub-surf	B-09	17.3		0.3		0.6	0.5	0.6				
surface	B-10	15.8		0.2		0.5	0.4	0.6				
sub-surf	B-10	13.9		0.3		0.7	0.7	0.7				
surface	B-13	19.2		0.2		0.5	0.5	0.4		0.9		
sub-surf	B-13	13.8		0.2		0.7	0.6	0.5				
surface	B-17	13.2	1.1	0.4		0.9	1.4*	1.6*			1.0	
sub-surf	B-17	17.3		0.3		0.6	0.7	0.7				
surface	B-19	15.1	0.7	0.3		0.6	0.6	0.7				
sub-surf	B-19	16.5				0.6	0.4	0.5				
surface	B-20	11.0		0.2		0.7	0.5	0.5				
sub-surf	B-20	11.7				0.5	0.5	0.8				
surface	B-33	13.6		0.3		0.9	0.9	1.0				
sub-surf	B-33	7.8				0.5	0.6	0.7				
surface	C-09	13.5		0.3		0.6	0.6	0.8			0.8	
sub-surf	C-09	15.9		0.3		0.6	0.7	0.7				
surface	C-15	17.5		0.2		0.5	0.5	0.4				
sub-surf	C-15	17.5		0.3		0.6	0.5	0.5				
surface	C-17	12.0	0.2	0.5	0.9	2.0*	2.2*	2.2*		4.5*	1.7*	2.6*
sub-surf	C-17	16.1		0.2		0.6	0.5	0.6				
surface	C-24	6.2	0.5	0.2		0.5	0.6	0.6				
sub-surf	C-24	7.0		0.2		2.7*	0.4	0.4				
surface	C-26	11.4	1.1	0.2		0.6	0.6	0.7		6.3*	0.7	14.9*
sub-surf	C-26	17.1	0.2	0.3		0.6	0.5	0.5				
surface	C-28	9.9	0.3			0.6	0.5					
sub-surf	C-28	12.2		0.4		0.8	0.9	0.9				
surface	C-32	15.7	0.3			0.6	0.7	0.6				
sub-surf	C-32	13.9		0.3		0.8	0.8	0.9				
surface	C-33	9.6		0.6*		1.5*	1.3*	1.3*		7.2*	1.7*	8.7*
sub-surf	C-33			0.6*		1.6*	3.7*	4.0		10.0*	1.6*	6.2*
surface	D-10	19.0				0.5	0.3	0.5				
sub-surf	D-10	14.2		0.2		0.4		0.4				

Table C-3
GSA Site Soil Survey
Gamma Spectrum Analyses (pCi/g)
(continued)

Location	Grid	K-40	Cs-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234
surface	D-17	12.2	0.3	0.4		1.2	1.3*	1.3*		3.8*	1.1	
sub-surf	D-17	18.5		0.3		0.6	0.6	0.5				
surface	D-21	15.6		0.2		0.4	0.5	0.5				
sub-surf	D-21	15.2		0.3		0.4	0.6	0.6				
surface	D-23	11.8	0.4			0.6	0.6	0.6				
sub-surf	D-23	13.9				0.5	0.5	0.5				
surface	D-28	14.9	0.4			0.6	0.7	0.6				3.3*
sub-surf	D-28	15.7		0.3		0.5	0.5	0.6				
surface	D-30	11.8	0.4			0.6	0.7	0.6				
sub-surf	D-30	15.5		0.3		0.6	0.7	0.6				
surface	E-07	15.6				0.3	0.4	0.5				
sub-surf	E-07	16.9				0.4	0.5	0.6				
surface	E-13	12.7		0.3		0.6	0.6	0.7				
sub-surf	E-13	11.8		0.3		0.4	0.6	0.5				
surface	E-16	11.6	1.1	0.3		1.1	1.3*	1.4*				
sub-surf	E-16	10.5		0.2		0.5	0.4	0.5				
surface	E-17	13.7	0.4	0.4		1.0	2.0*	2.1				
sub-surf	E-17	15.7		0.3		0.8	0.6	0.8				
surface	E-18	15.6	0.9	0.4		0.7	1.2*	1.3*			0.8	
sub-surf	E-18	12.0				0.5	0.7	0.6			0.8	
surface	E-19	17.0				0.5	0.9	1.0			0.8	
sub-surf	E-19	6.8		0.2		0.5	0.6	0.7				
surface	E-20	15.9	0.7	0.7		2.2*	4.4*	4.8*		9.2*	1.9*	
sub-surf	E-20	11.3		0.3		0.9	1.3*	1.4*			1.0	
surface	E-31	18.3		0.3		0.8		0.7				
sub-surf	E-31	20.0		0.4		1.0	0.8	0.9				
surface	E-33	13.7	0.3	0.5*		1.2	0.9	1.0			1.6*	
sub-surf	E-33	6.9	0.6	0.4		0.8	1.8*	2.1*				
surface	F-07	15.7										
sub-surf	F-07	12.9		0.3		0.7	0.6	0.7				
surface	F-14	11.7	0.8	0.2		0.5	0.7	0.8				
sub-surf	F-14						0.1	0.1				
surface	F-18	11.1	0.6	0.3		0.6	0.8	0.9			0.9	
sub-surf	F-18	12.4				0.6						
surface	F-22	13.1	0.5	0.4		1.0	2.1*	2.3*				
sub-surf	F-22	17.0		0.2		0.6	0.7	0.7				
surface	F-23	11.5				0.6	0.8	1.2*				
sub-surf	F-23	13.2				0.5	0.6	0.6				

Table C-3
GSA Site Soil Survey
Gamma Spectrum Analyses (pCi/g)
(continued)

Location	Grid	K-40	Cs-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234
surface	F-24	13.4	0.4	0.4		0.7	1.3*	1.2*				
sub-surf	F-24	4.9		0.1		0.4	0.3	0.4				
surface	F-27	11.0	0.9			0.5		0.6		6.7*		11.6*
sub-surf	F-27	11.3				0.8	1.0*	0.8		5.4*		
surface	G-05	15.6	0.9	0.3		0.9	0.5	0.9				
sub-surf	G-05	16.3	0.3	0.3		0.6	0.6	0.6				
surface	G-23	14.0		0.2		1.0	0.7	0.7			0.9	
sub-surf	G-23	5.3		0.3		0.7	0.7	0.8				
surface	G-26	15.3	0.7	0.4		0.7	1.0	0.9				
sub-surf	G-26	15.6				0.9	2.3	2.7				
surface	G-28	15.3				0.4						
sub-surf	G-28	16.9										
surface	H-07	15.9		0.2		0.4	0.3	0.4				
sub-surf	H-07	15.7		0.3		0.6	0.7	0.6			0.8	
surface	H-13	10.5				0.5		0.6				
sub-surf	H-13	10.1				0.4	0.6	0.5				
surface	H-16	12.6	0.9			0.5	0.9	0.7				
sub-surf	H-16	13.5		0.2		0.7	0.8					
surface	H-17	16.4		0.3		0.8	0.9	0.8			0.9	
sub-surf	H-17	12.2		0.3		0.7	0.8	0.9				
surface	I-04	14.0	0.3	0.3		0.6	0.5	0.6				
sub-surf	I-04	12.0				0.6	0.5	0.6				
surface	I-08	10.1	0.8	0.2		0.7	1.1	0.9				
sub-surf	I-08	9.7				0.8	0.8	0.9			0.8	
surface	I-09	11.1	0.9	0.4		0.8	1.2*	1.5*				
sub-surf	I-09	7.5		0.3		0.6	0.6	0.8				
surface	I-10	11.2	1.5			0.9	1.2*	1.1*				
sub-surf	I-10	8.5		0.3		0.9	1.0	1.0				
surface	J-03	9.3				0.5	0.5	0.5				
sub-surf	J-03	15.1		0.5		0.9	0.9	0.8				
surface	J-09	9.9	0.7	0.3		0.7*	0.6					
sub-surf	J-09	12.7	0.4	0.3		0.6	0.7	0.8				
surface	K-04	15.1		0.3		0.7	0.7	0.8				
sub-surf	K-04	6.4				1.0	0.8	0.9	1.4*			
surface	L-03	23.6*		0.5*		1.3	1.0	1.1			1.6	
sub-surf	L-03	5.5		0.2		0.4	0.6	0.6				

* Indicates results in excess of off-site mean + 3s.

Blank cell indicates that the nuclide was not detected.
Asterisk (*) denotes concentration above 3 standard deviations of the off-site mean.

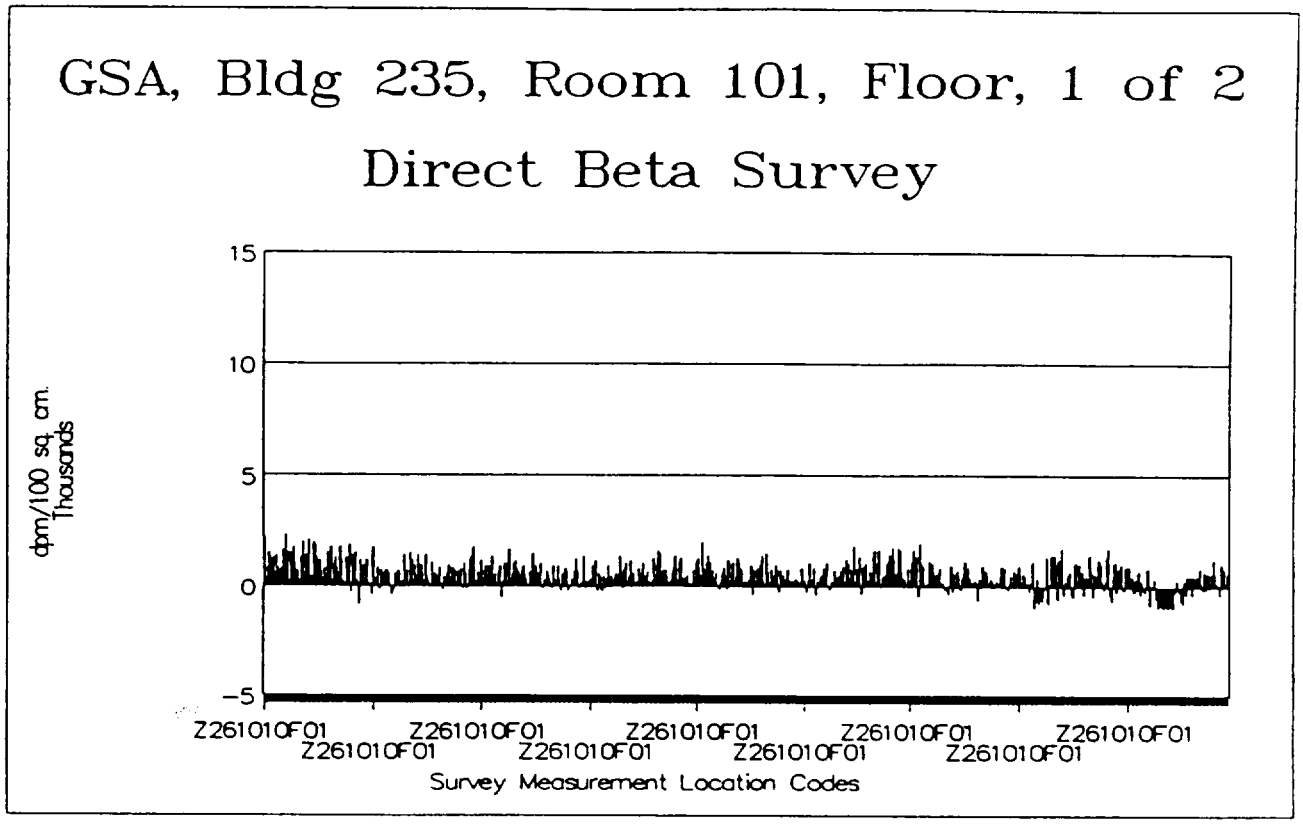
Table C-4
GSA Site
Gamma Exposure Rate Measurements*

Grid	A	B	C	D	E	F	G	H	I	J	K	L
2												12.8
3										12.6	14.6	19.1
4								15.3	15.1	12.5	14.6	
5							10.1	15.3		14	15	
6						11.8	12.5	15.4	13.4	12.3		
7				10.3	12.5	13.7		16	14.7	12.6		
8			11.7	12.8				16	14.2	13.1		
9		14	15.7			12.9	12.3	15.6	14.1	15.1		
10		13.7		13	13.2			15.3	14.9			
11	13.7	14.3	14.3	15.2			13.2	13.8	12.8			
12	13.6	14.7				12.8	12.2	13.6	12.1			
13	13.6	15.9			13.7	11.9		12.6				
14	14.4	14.7		14.3	14	13.2		10.7				
15	14.8	14.1	14	13.8	14.3	13.6	11.7	10.8				
16	14.2	14.7	15.5	14.6	18	13.2	12.4	12.7				
17	13.7	17	17.5	15.4	17.9	14.3	12.5	12.4				
18	13.5	16.4	16.4	15.8	17.3	14.4	13.5	12.8				
19	14	13.3	13	12.1	16.1	14	13.8	14.3				
20	14.2	12.2	12.5	12.3	18.8	13.6	13.6	14.7				
21	11.3	11.6	12.3	13.8	14	16	13.9	14.4				
22	12	11.4	11.5	12.7		15.7	14.4	15.2				
23	13.5	12.7	13.3	13.3	12	13.8	14.5					
24	13.9	12.6	12.4	13	13.2	15.2	13					
25	12.5	14.4	14.6	14.8	15	15.1	14.1					
26	11.5	15.2	15	14.7	14.7	13.8	12.1					

Table C-4
GSA Site
Gamma Exposure Rate Measurements*
(Continued)

Grid	A	B	C	D	E	F	G	H	I	J	K	L
27	12.4	12.5	13.6	13.7		12	11.9					
28	13.1	12.3	13	13.6	12.4	12.1	14.3					
29		12.7	13.1	13.5	13.3	13.8						
30		13.2	13.9	12.9	13.9	15.3						
31		15.5	13.1	12.8	12.3	14.4						
32		13.3	13.6	13.8	13.8	14.8						
33		14.4	17.9	15.9	15.5							
		Average dose rate uR/hr at 1 meter						13				

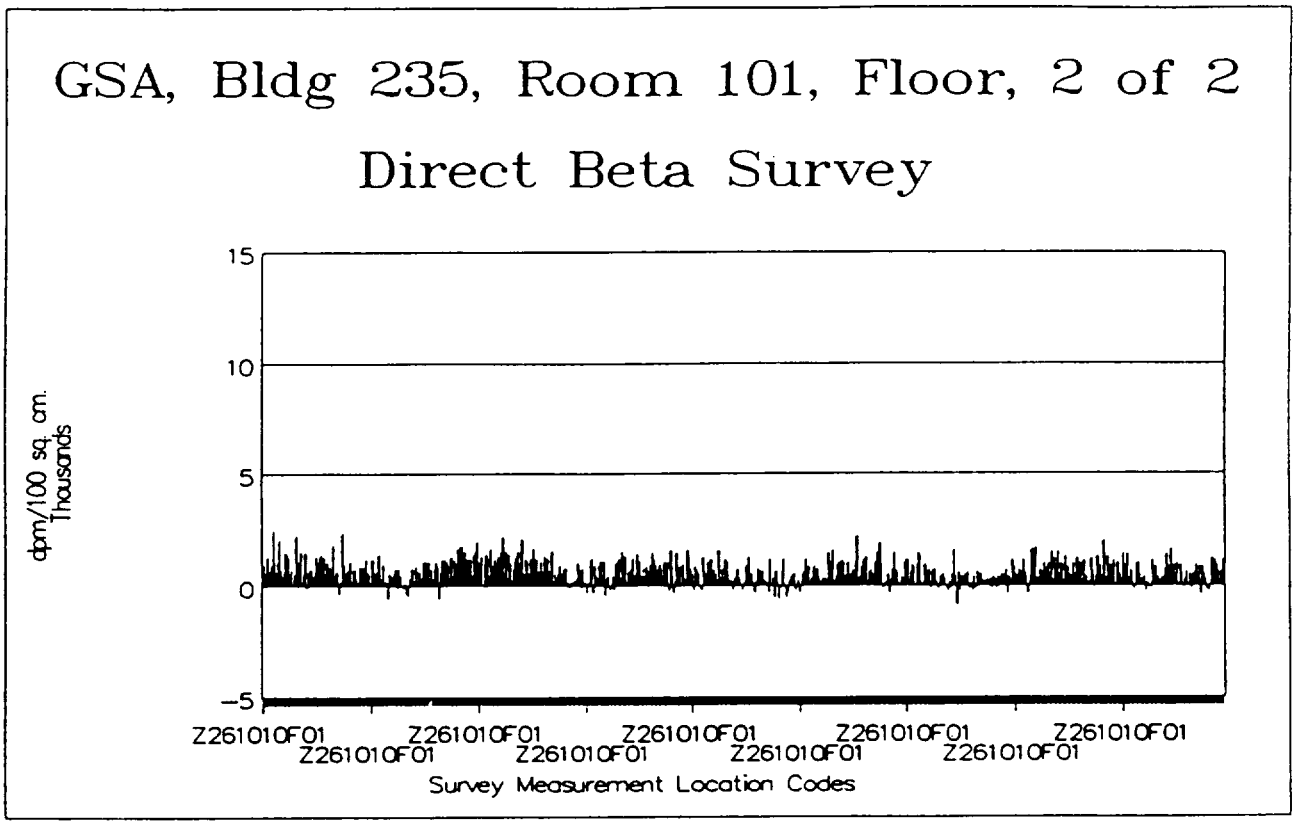
* This sheet is the data for the gamma radiation measurements made at the GSA site in 1993. These have been ordered by grid intersection location so they can be plotted in 3D.



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
496	565	625	2297	534	2405

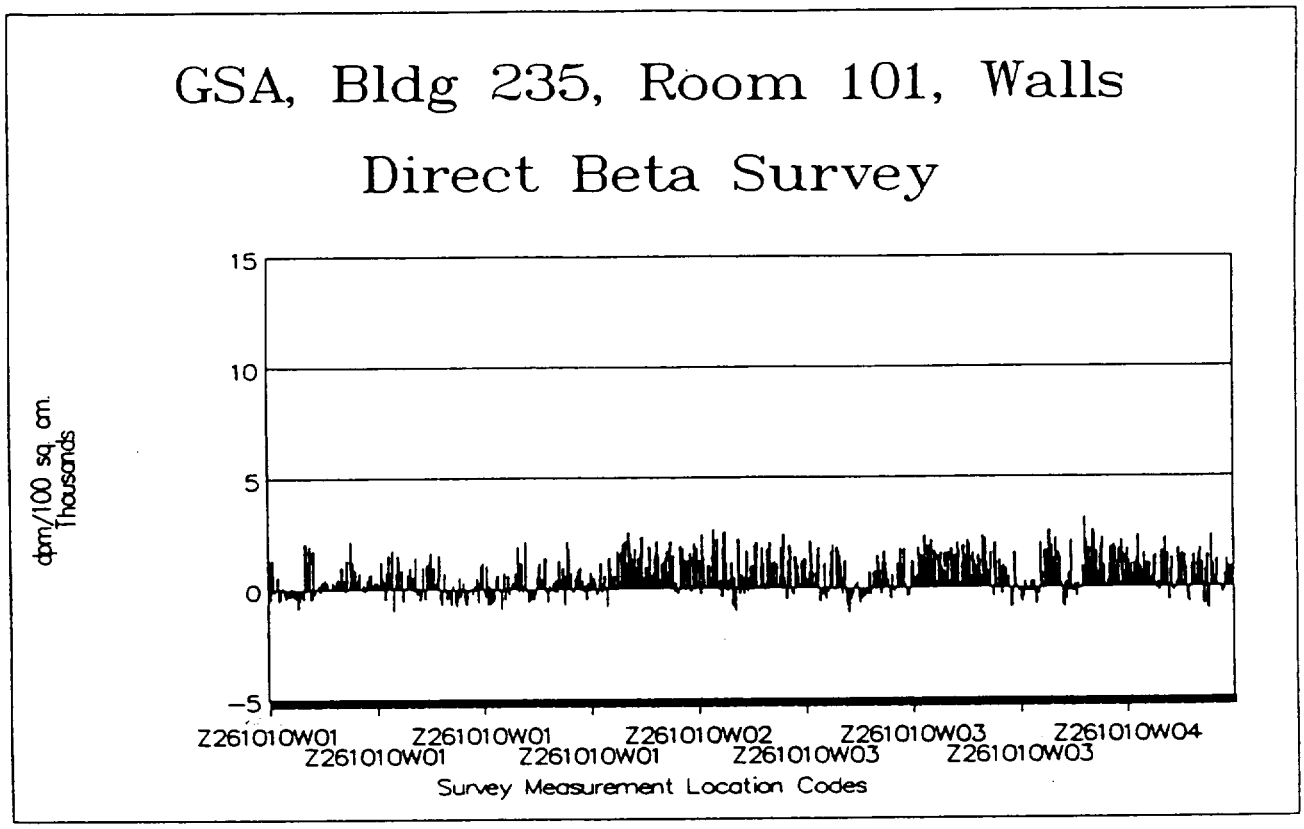
Figure C-4
GSA Building 235 floor (1 of 2) (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
642	511	625	2431	676	2511

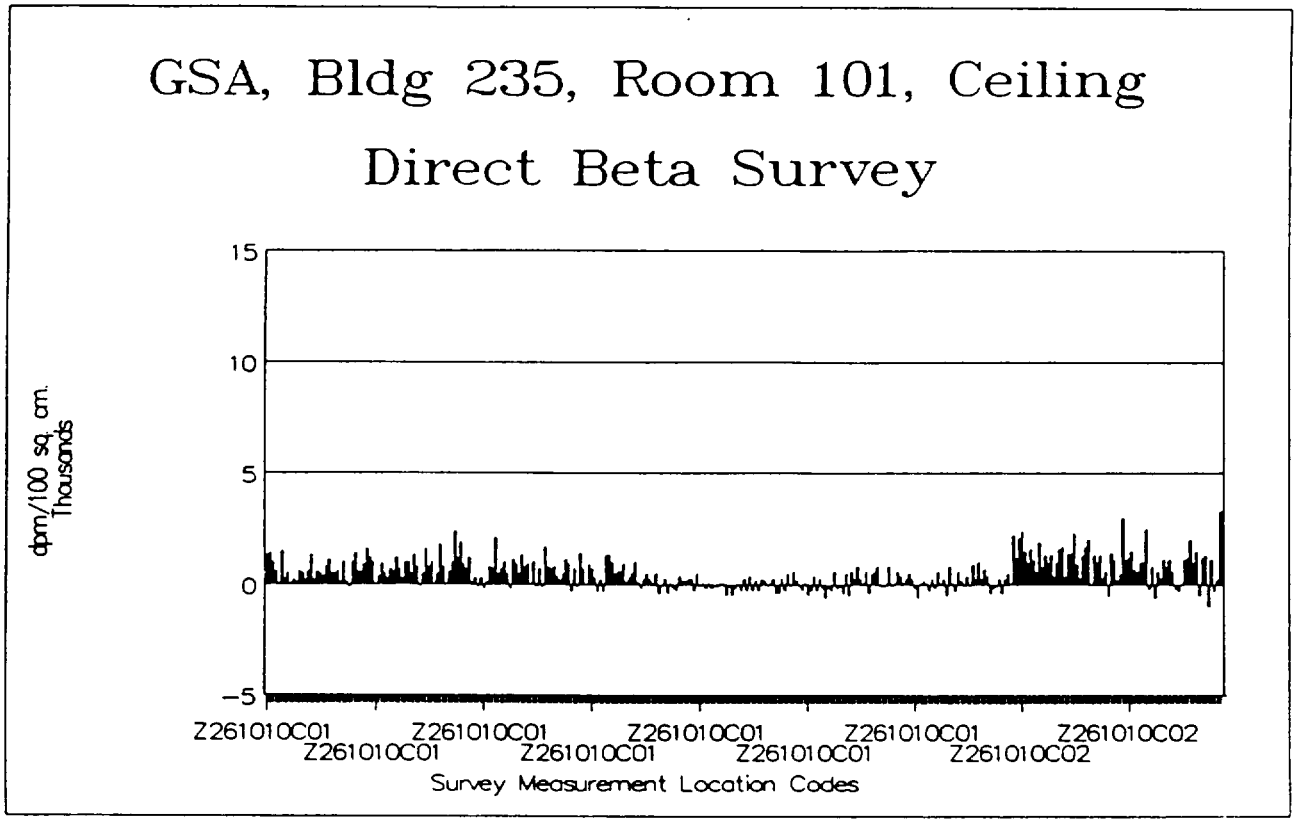
Figure C-5
GSA Building 235 floor (2 of 2) (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
622	829	700	3180	675	3296

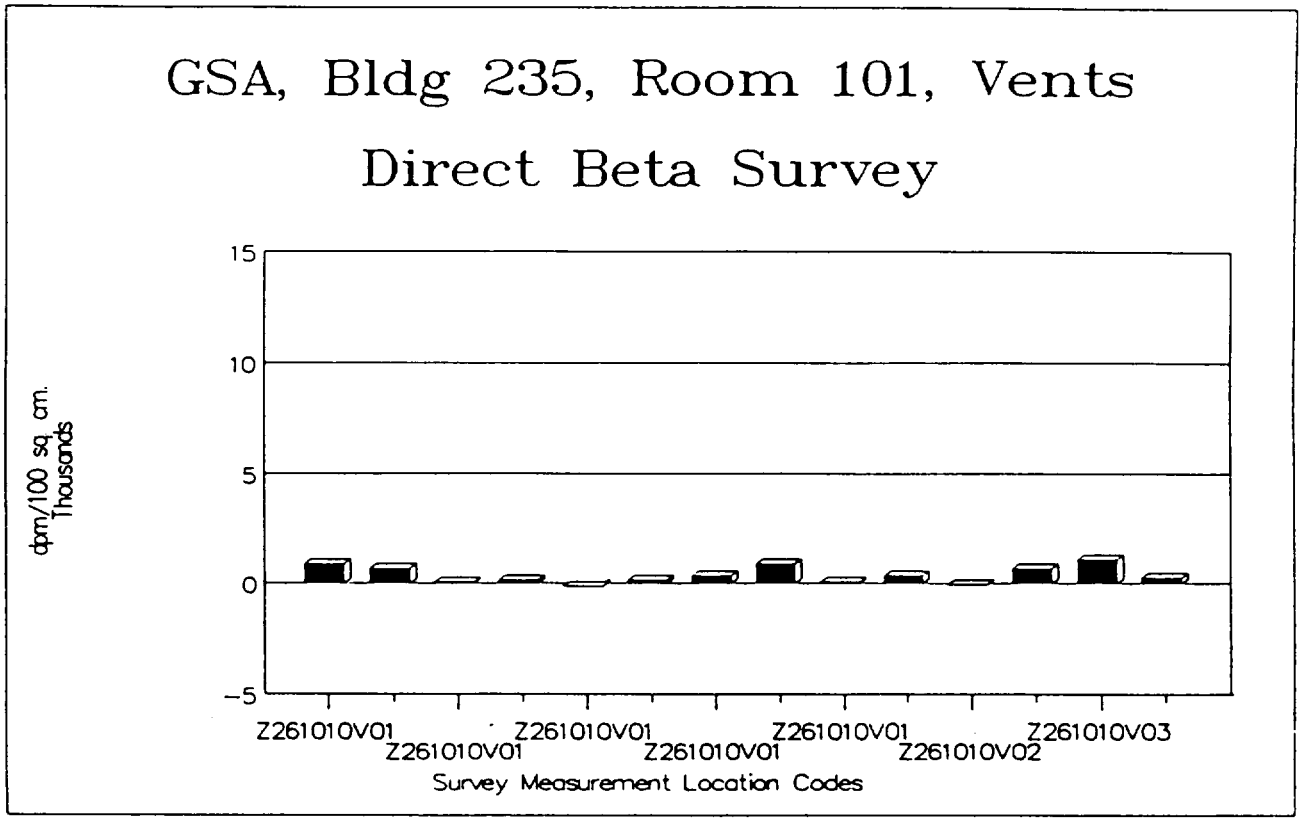
Figure C-6
GSA Building 235 walls direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
505	651	328	3256	566	3568

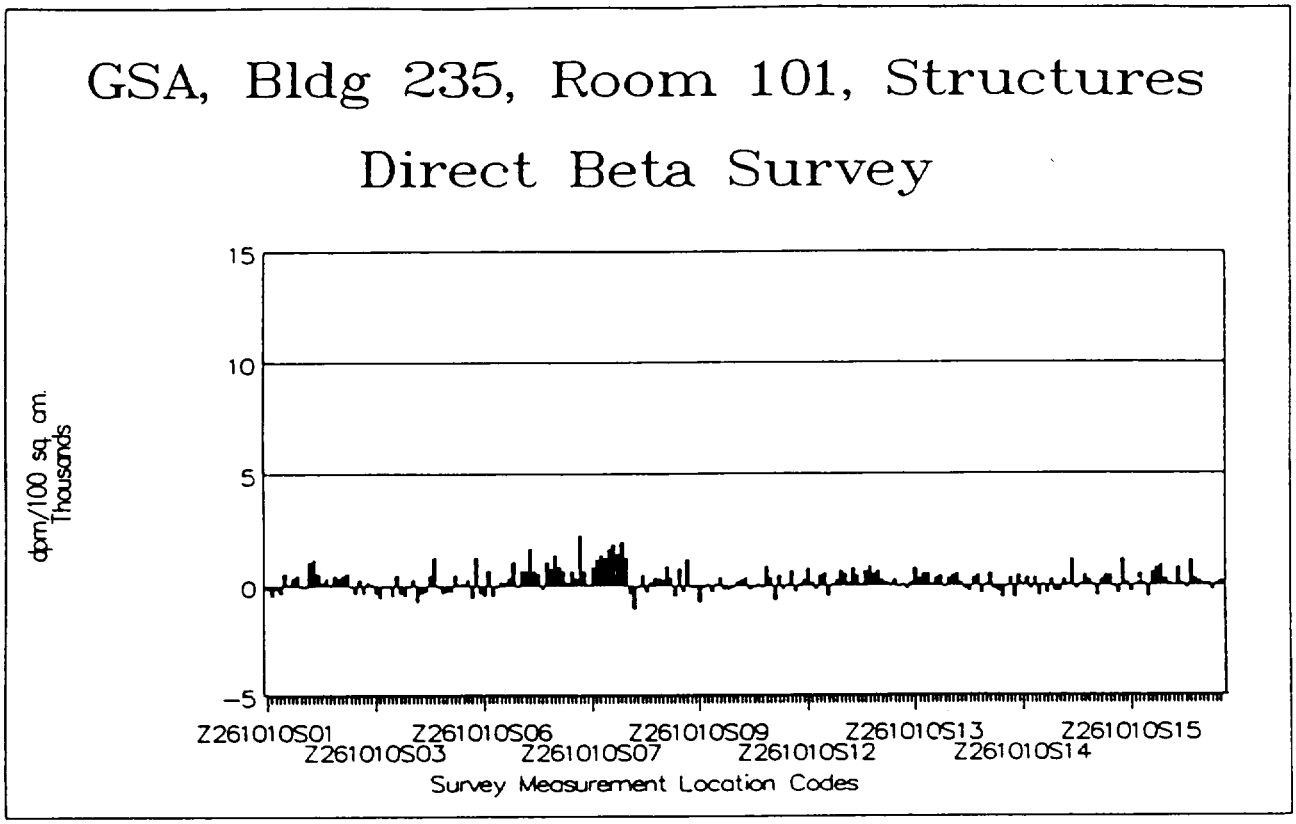
Figure C-7
GSA Building 235 ceiling direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
363	378	14	1045	547	1340

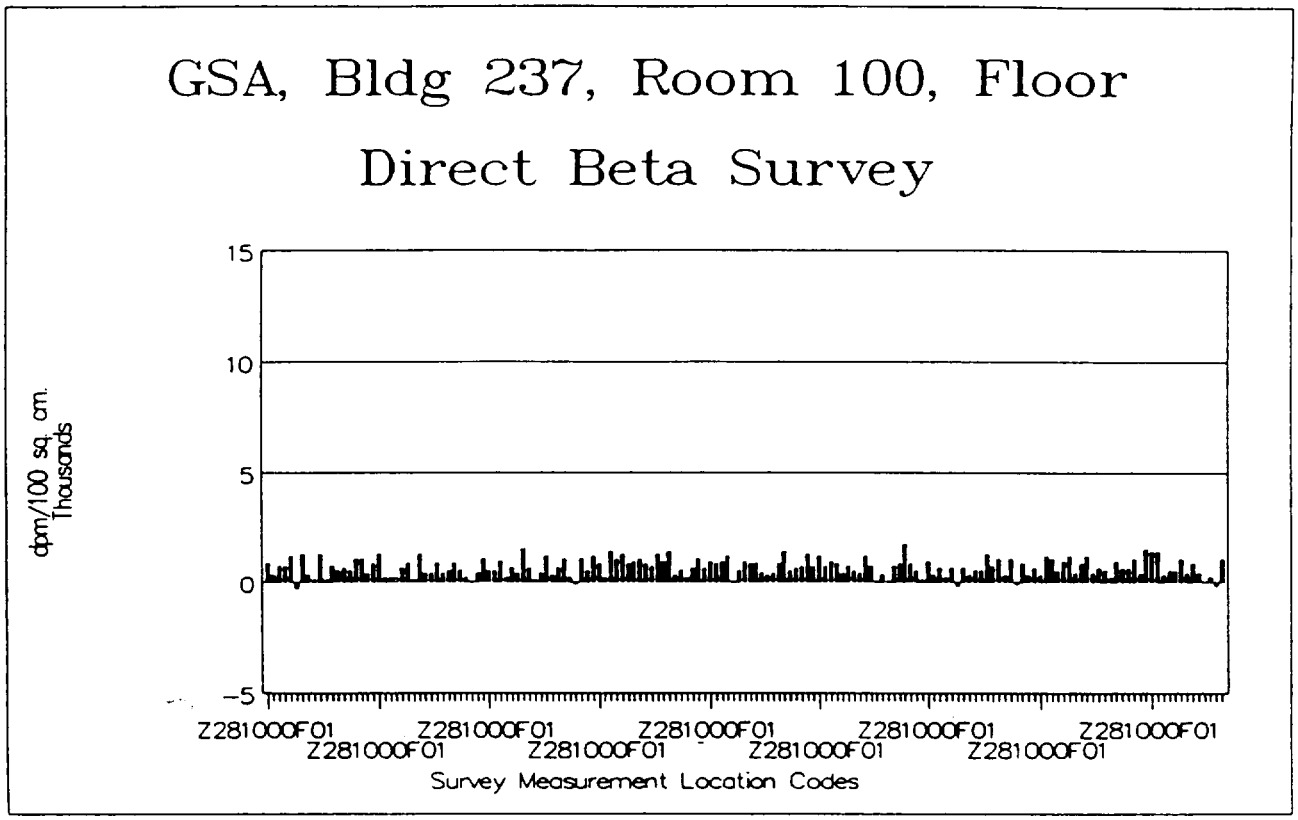
Figure C-8
GSA Building 235 vents direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
229	517	230	2251	287	2479

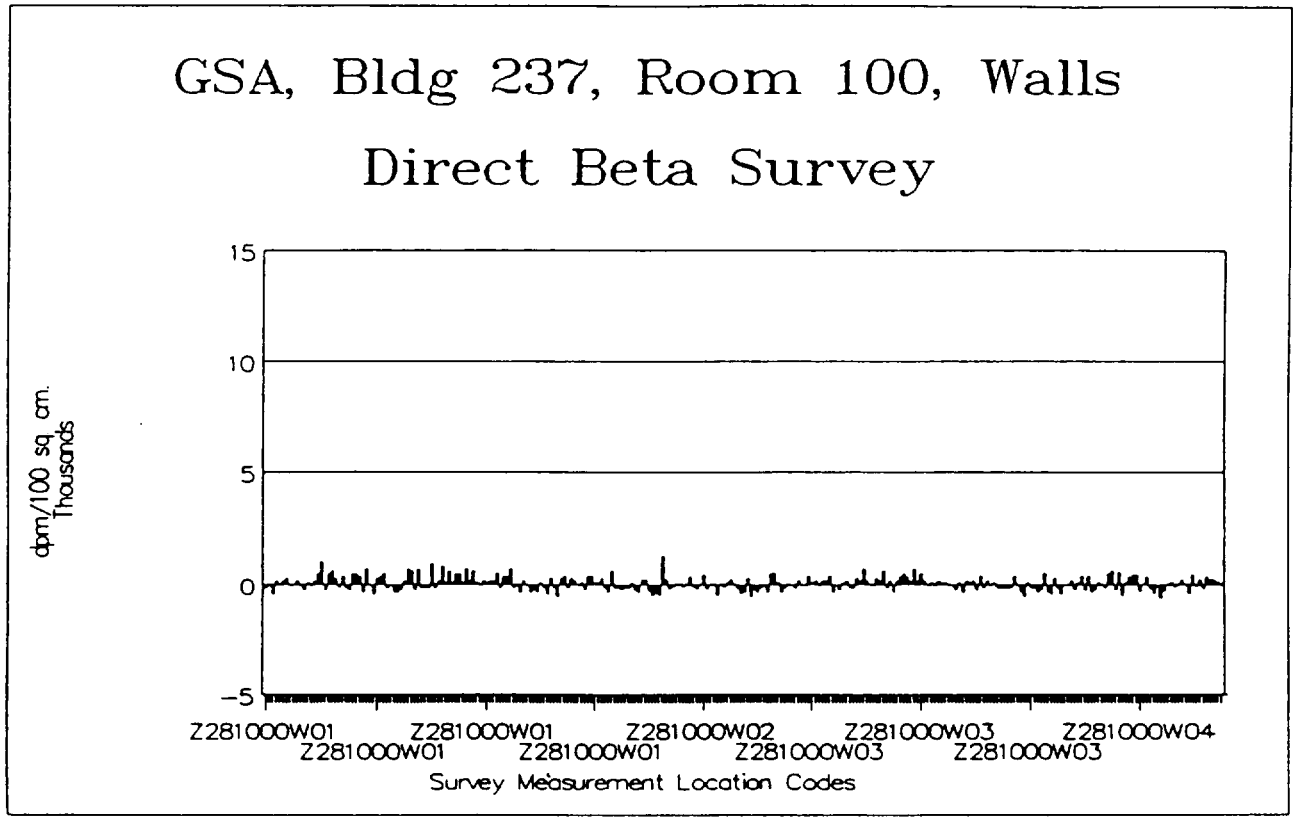
Figure C-9
GSA Building 235 structures direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
672	391	165	1668	723	1803

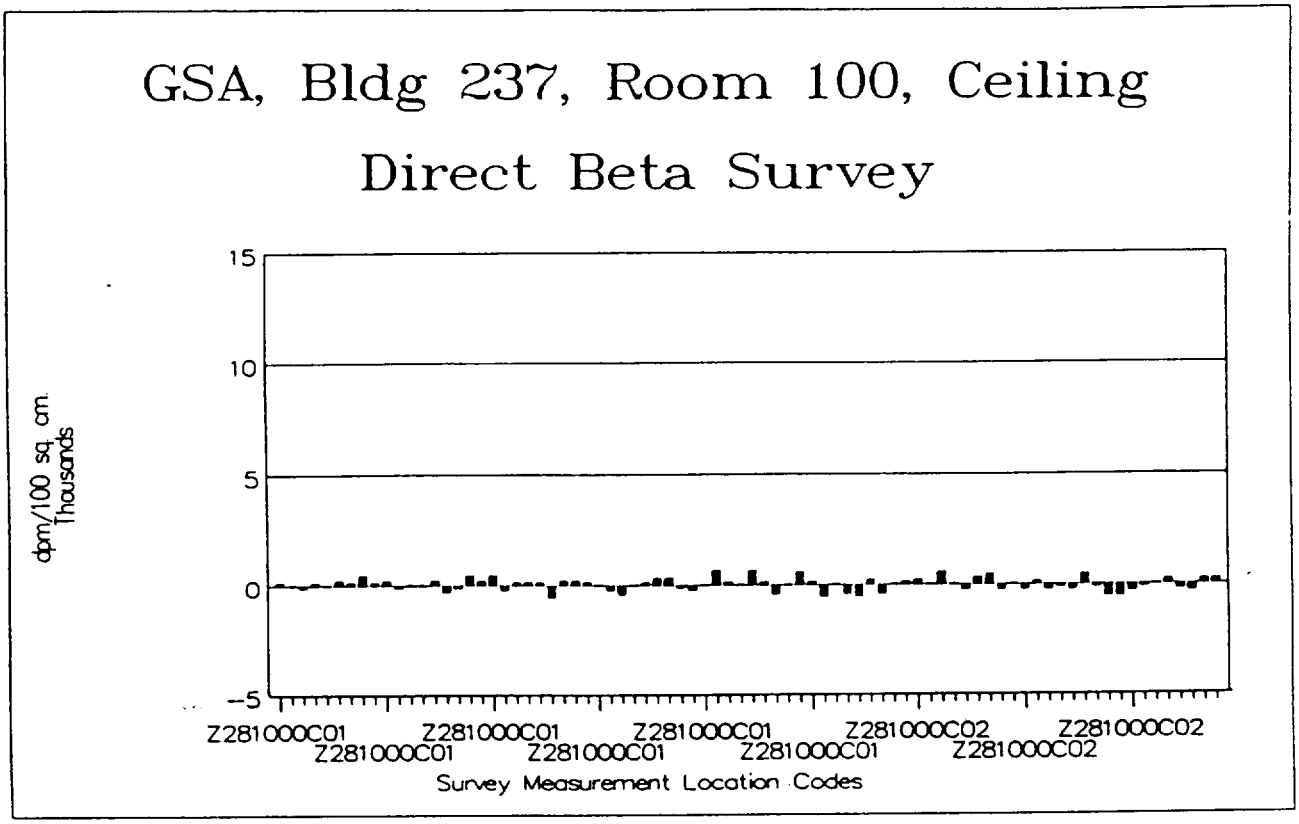
Figure C-10
GSA Building 237 floor direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
44	309	280	1254	75	1388

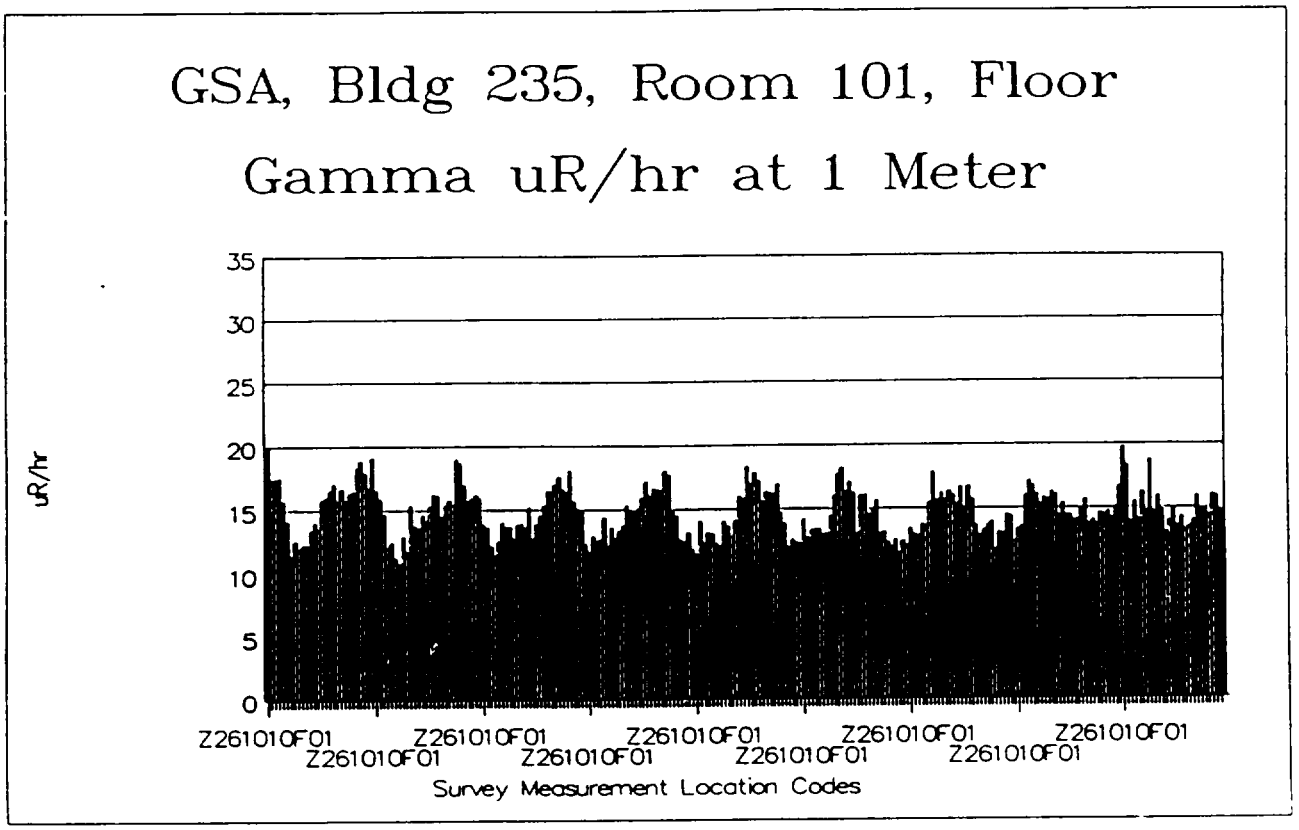
Figure C-11
GSA Building 237 walls direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
-0	282	80	629	54	754

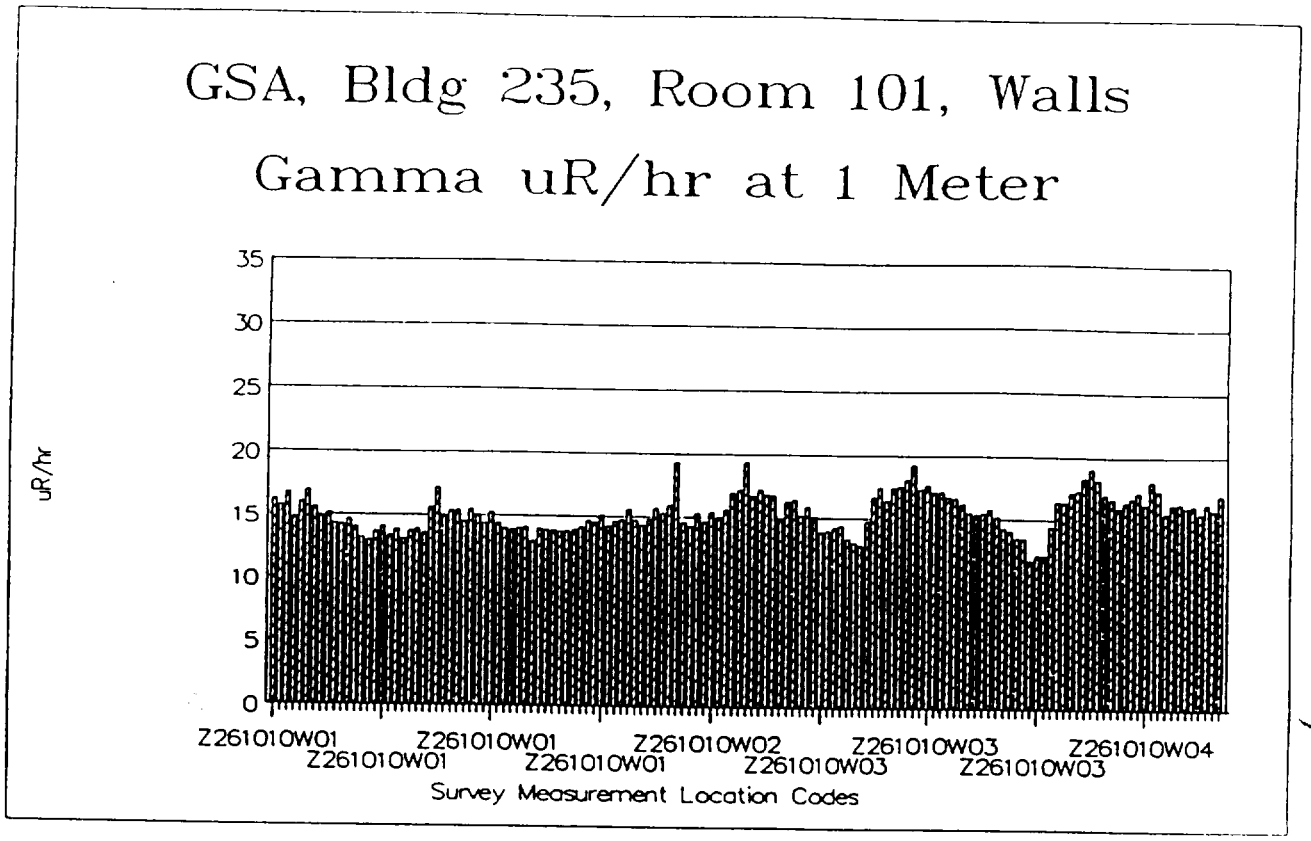
Figure C-12
GSA Building 237 ceiling direct measurement results (dpm/100 cm²)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
14.8	1.8	250	20.0	19.3	20.3

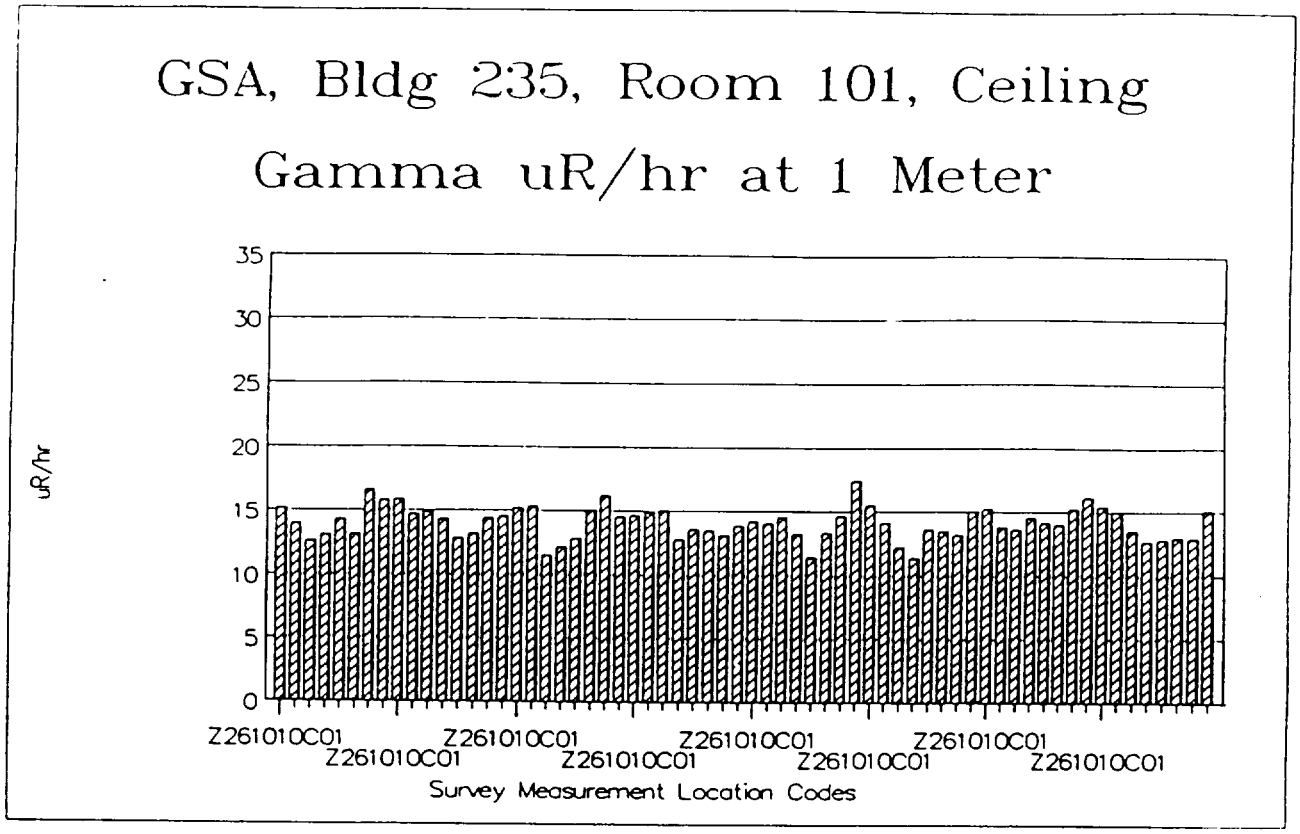
Figure C-13
GSA Building 235 floor gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
15.4	1.6	140	19.4	19.3	20.1

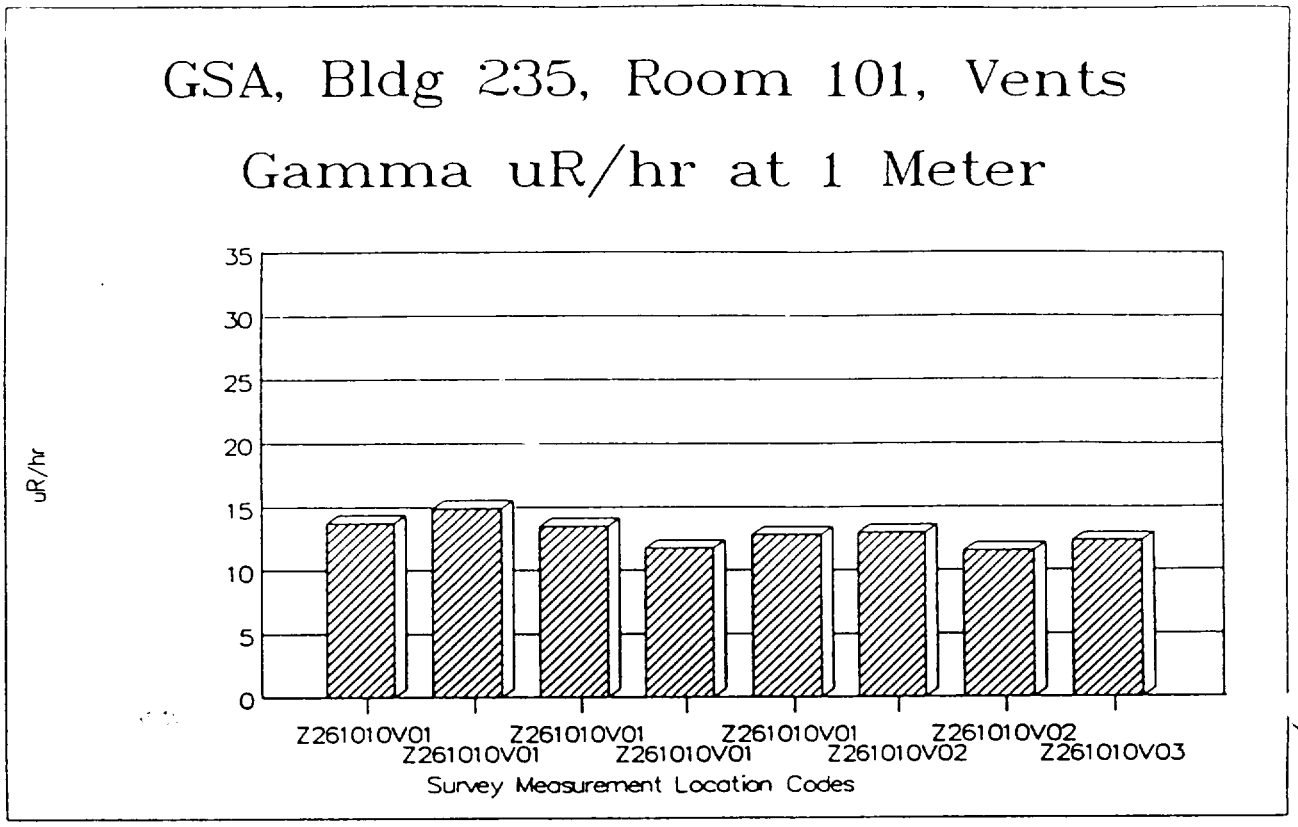
Figure C-14
GSA Building 235 walls gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
14.1	1.3	64	17.4	17.2	17.8

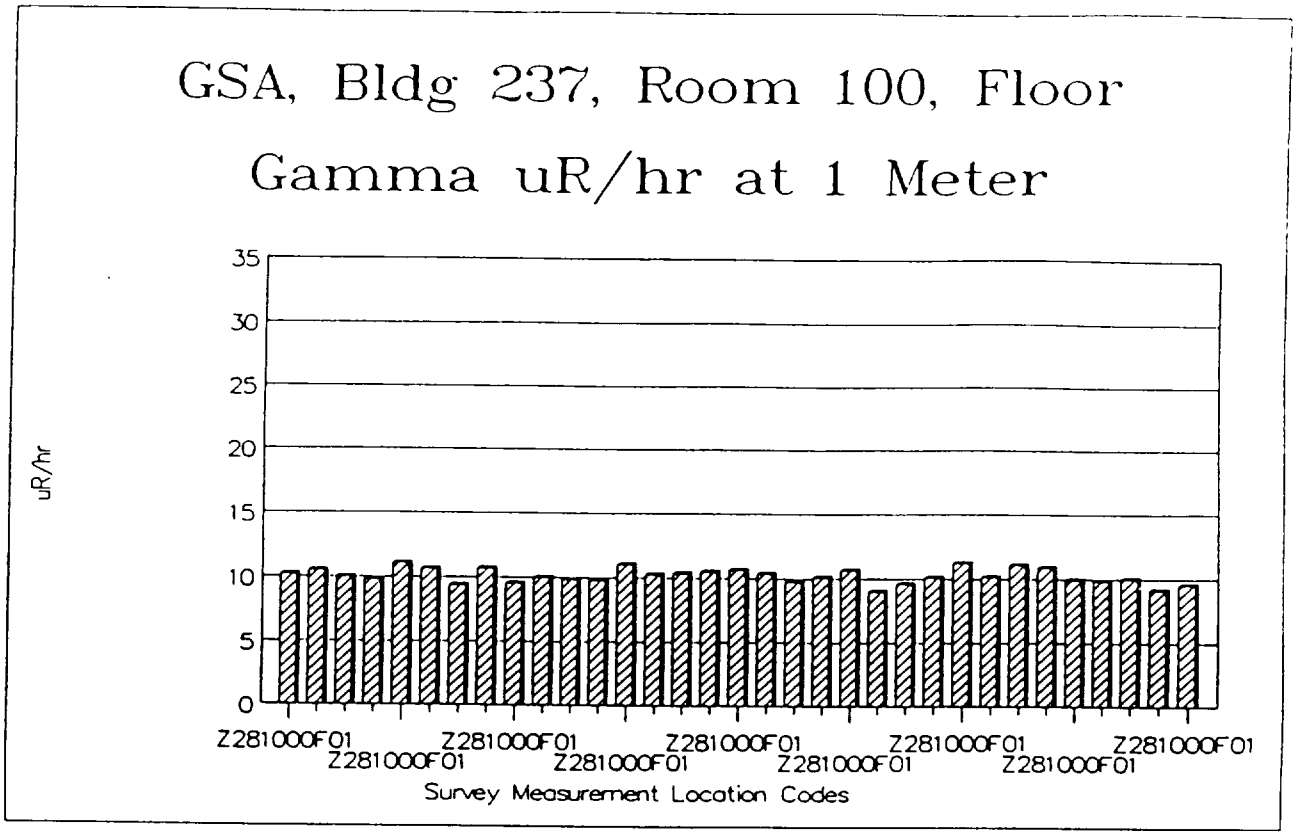
Figure C-15
GSA Building 235 ceiling gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
12.9	1.1	8	14.9	16.4	16.3

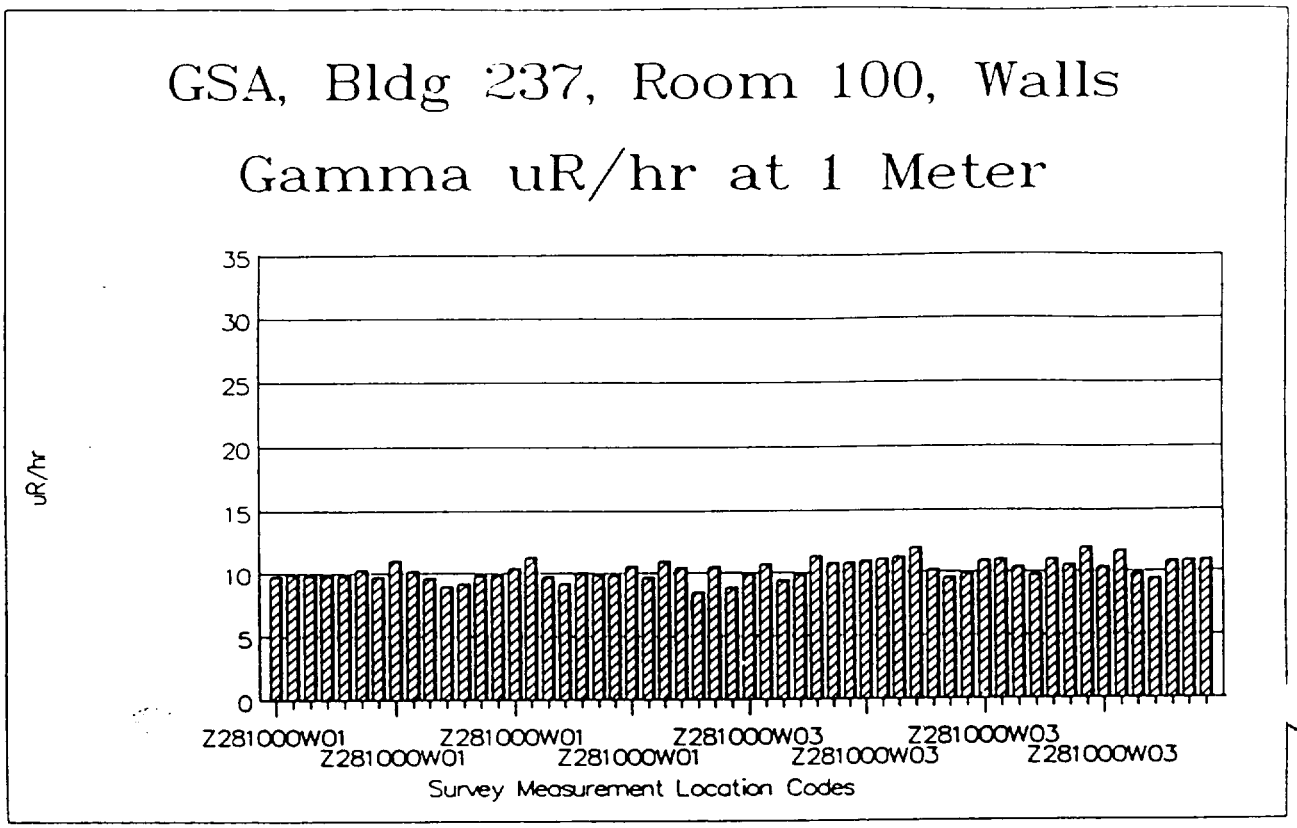
Figure C-16
GSA Building 235 vents gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. + t (.99)s	Avg. * + 3 s
10.2	.6	33	11.2	11.5	11.8

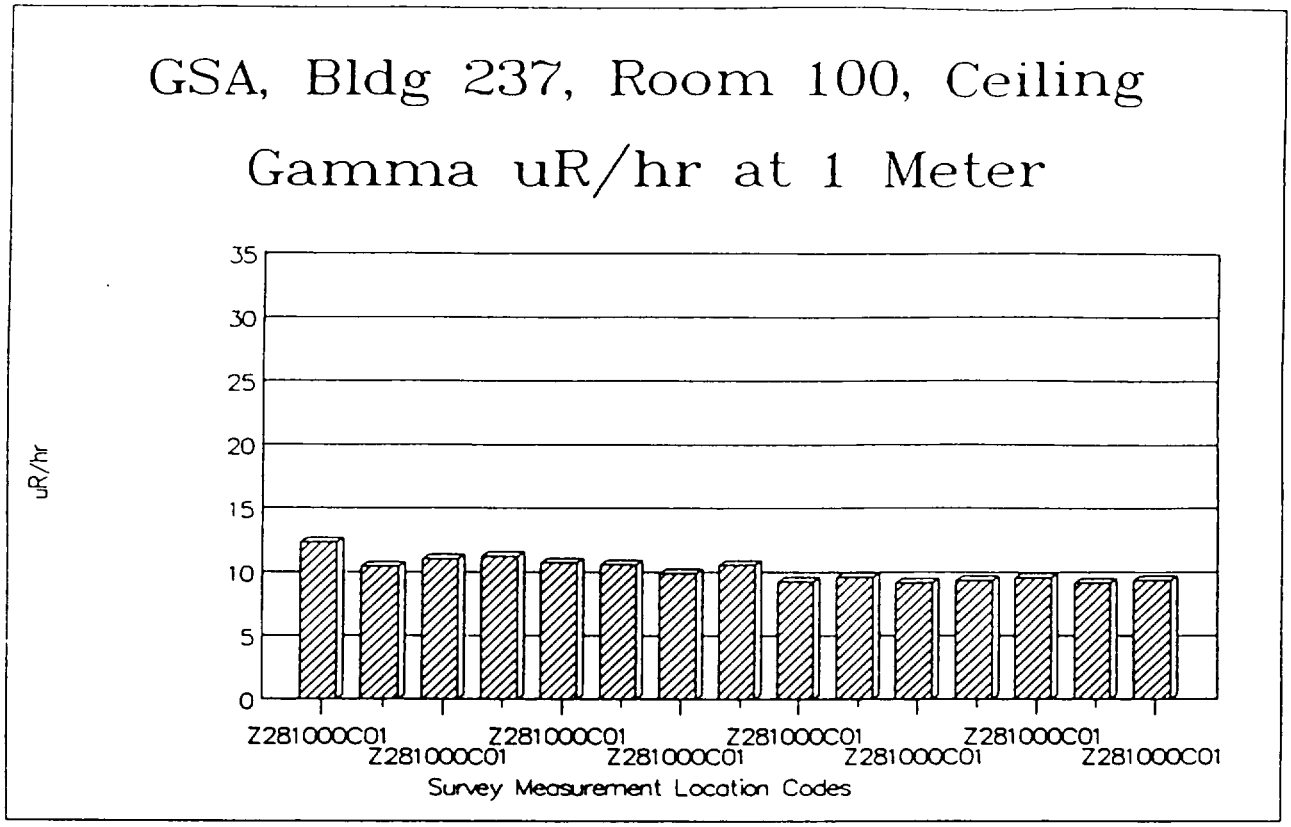
Figure C-17
GSA Building 237 floor gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
10.1	.7	56	11.8	12.0	12.3

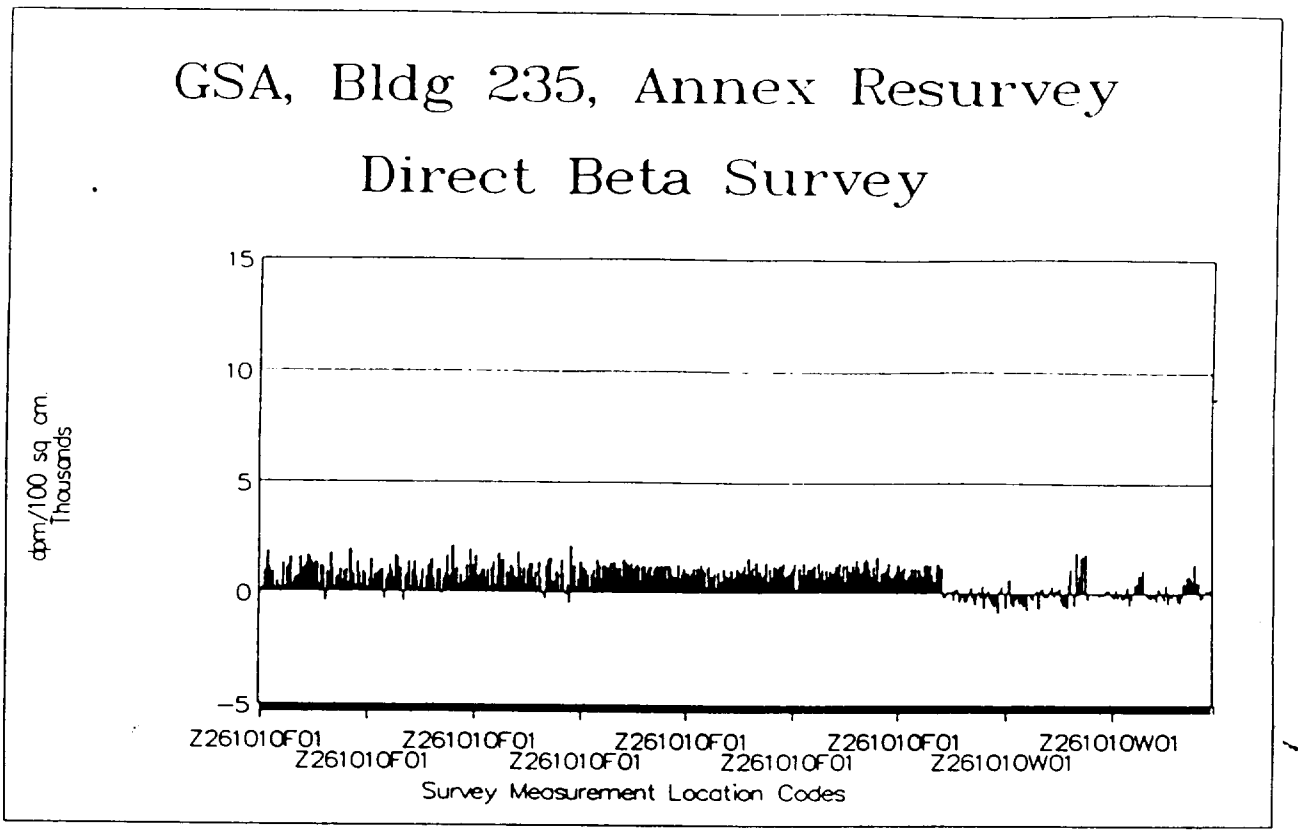
Figure C-18
GSA Building 237 walls gamma exposure rate results (μR/hr)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +*t* (.99)s	Avg. * + 3 s
10.1	.9	15	12.3	12.7	12.9

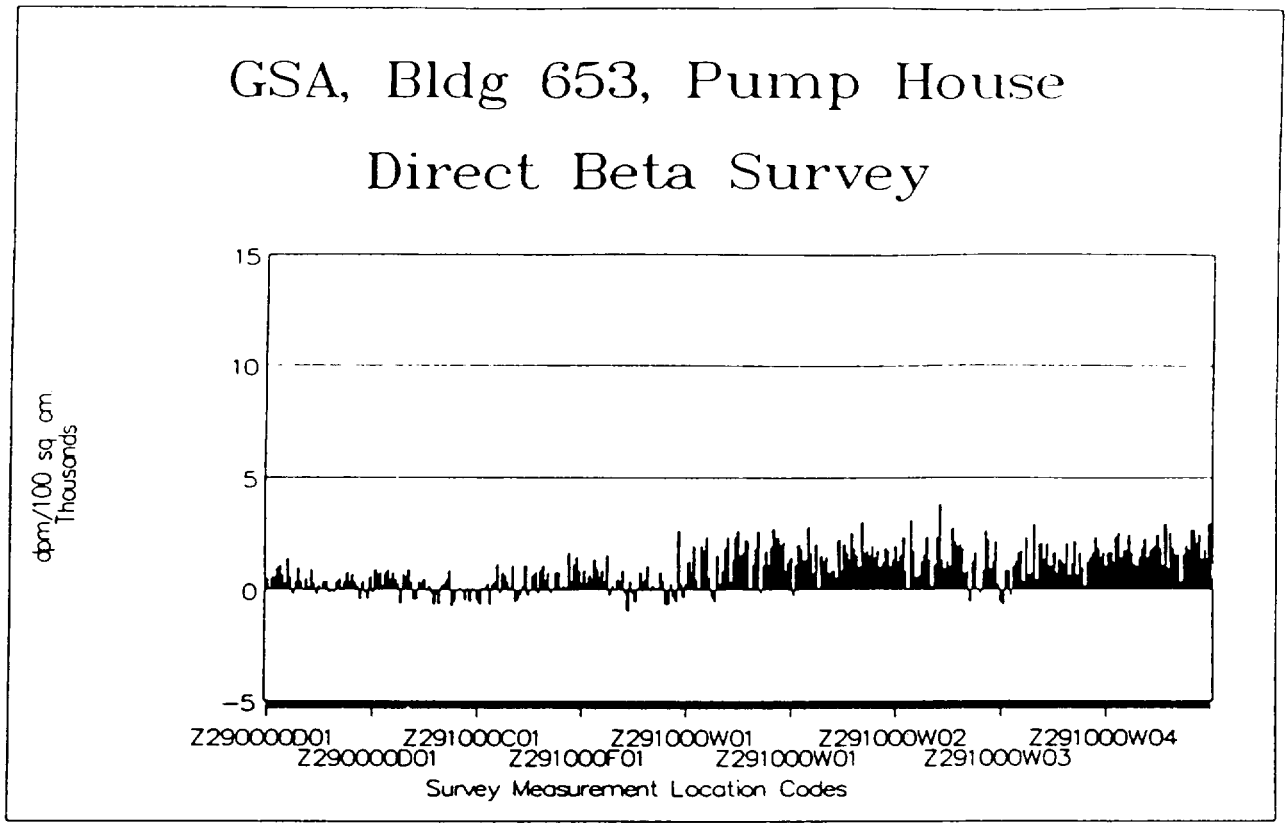
Figure C-19
GSA Building 237 ceiling gamma exposure rate results (μR/hr)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
638	577	500	2,105	682	2,178

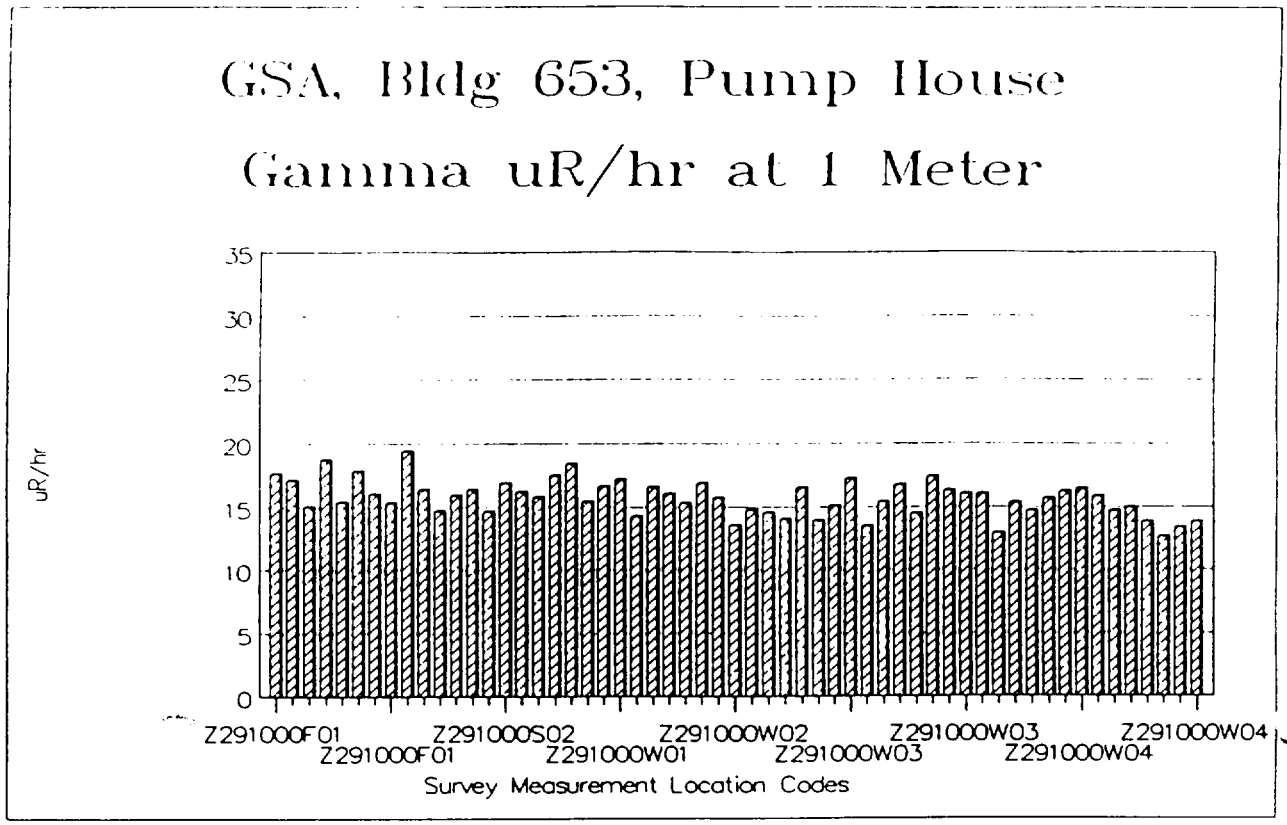
Figure C-20
GSA Building 237 Annex resurvey direct measurement results (dpm/100 cm²)



Direct Beta Survey Statistics

Mean	Std Dev	Number	Maximum	95% CL on Mean	95% CL Max Mean
929	898	369	3,798	1,008	3959

Figure C-21
GSA Building 653 pumphouse direct measurement results (dpm/100 cm²)



Gamma Survey Statistics

Avg.	Std Dev	Number	Maximum	Avg. +t (.99)s	Avg. * + 3 s
15.7	1.4	57	19.4	19.3	20.0

Figure C-22
GSA Building 653 pumphouse gamma exposure rate results (μR/hr)

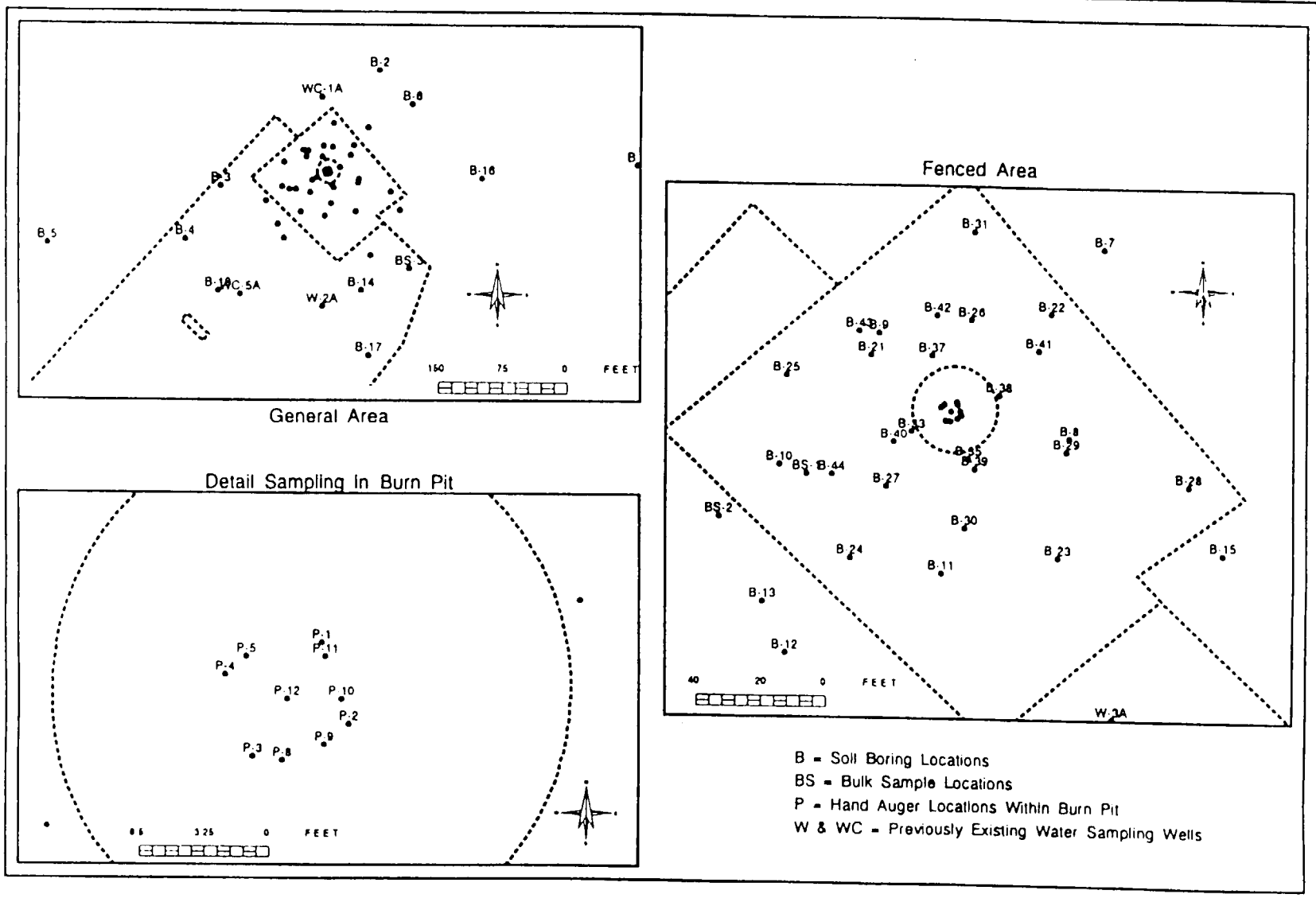


Figure C-23. Soil boring locations, 1993, 1994, including wells

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0518S	1201	Burn Pit	Bore 32	No. 1					0.1	57.0	1.09	DU	2.39
GSA0523S	328	Burn Pit	Bore 32	No. 2					6.1	75.6	1.44	U+d	15.87
GSA0524S	943	Burn Pit	Bore 32	No. 3					2.2	35.0	0.67	U+d	7.28
GSA0525S	261	Burn Pit	Bore 32	No. 4					-11.2	35.6	0.68	DU	1.49
GSA0526S	160	Burn Pit	Bore 32	No. 5					-5.5	17.5	0.33	DU	0.73
GSA0527S	132	Burn Pit	Bore 32	No. 6					-7.8	24.7	0.47	DU	1.04
GSA0519S	1113	Burn Pit	Bore 33	No. 1	1513	292.7	125.2	7.6	-25.6	81.4	1.55	DU	3.42
GSA0522S	981	Burn Pit	Bore 33	No. 2	1513	292.7	125.2	7.6	-13.4	42.5	0.81	DU	1.79
GSA0520S	1638	Burn Pit	Bore 33	No. 3	1513	292.7	125.2	7.6	0.3	8.7	0.16	DU	0.36
GSA0533S	635	Burn Pit	Bore 33	No. 4	1513	292.7	125.2	7.6	-3.0	9.7	0.18	DU	0.41
GSA0528S	134	Burn Pit	Bore 33	No. 5	1513	292.7	125.2	7.6	3.0	-9.7	-0.18	U+d	-1.65
GSA0521S	950	Burn Pit	Bore 34	No. 1					-29.0	92.2	1.76	DU	3.87
GSA0529S	395	Burn Pit	Bore 34	No. 2					-17.2	54.8	1.04	DU	2.30
GSA0530S	751	Burn Pit	Bore 34	No. 3					2.6	31.0	0.59	U+d	6.52
GSA0531S	524	Burn Pit	Bore 34	No. 4					4.0	12.2	0.23	DU	0.51

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	\ Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g: Estimated Ra-226	Concentration - pCi/g: Sand Corrected Th-234	Concentration - pCi/g: Estimated U-235	Material	Fraction of Limit
GSA0532S	282	Burn Pit	Bore 34	No. 5					-4.0	12.6	0.24	DU	0.53
GSA0536S	1224	Burn Pit	Bore 35	No. 1	1520	297.7	142.6	7	-11.4	63.0	1.20	DU	2.65
GSA0535S	571	Burn Pit	Bore 35	No. 2	1520	297.7	142.6	7	0.2	41.6	0.79	DU	1.75
GSA0534S	1431	Burn Pit	Bore 35	No. 3	1520	297.7	142.6	7	1.7	14.0	0.27	U+d	2.99
GSA0538S	616	Burn Pit	Bore 35	No. 4	1520	297.7	142.6	7	10.5	-1.4	-0.03	U+d	0.77
GSA0540S	144	Burn Pit	Bore 35	No. 5	1520	297.7	142.6	7	18.5	13.0	0.25	U+d	4.47
GSA0541S	1731	Burn Pit	Bore 36	No. 1					-0.8	2.5	0.05	DU	0.10
GSA0537S	97	Burn Pit	Bore 36	No. 2					33.4	-6.5	-0.12	U+d	2.01
GSA0542S	490	Burn Pit	Bore 36	No. 3					6.8	5.4	0.10	U+d	1.77
GSA0543S	302	Burn Pit	Bore 36	No. 4					11.8	3.7	0.07	U+d	1.93
GSA0539S	145	Burn Pit	Bore 36	No. 6					17.2	6.3	0.12	U+d	3.00
GSA0544S	1267	Burn Pit	Bore 37	No. 1	1514	315.6	131.4	8	1.8	5.3	0.10	U+d	1.25
GSA0550S	548	Burn Pit	Bore 37	No. 2	1514	315.6	131.4	8	4.0	1.6	0.03	U+d	0.71
GSA0547S	1174	Burn Pit	Bore 37	No. 3	1514	315.6	131.4	8	0.1	-0.3	-0.01	U+d	-0.05
GSA0546S	1068	Burn Pit	Bore 37	No. 4	1514	315.6	131.4	8	0.1	-0.4	-0.01	U+d	-0.07

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0551S	467	Burn Pit	Bore 37	No. 5	1514	315.6	131.4	8	4.6	0.5	0.01	U+d	0.56
GSA0552S	860	Burn Pit	Bore 37	No. 5A	1514	315.6	131.4	8	3.2	1.5	0.03	U+d	0.63
GSA0545S	1658	Burn Pit	Bore 38	No. 1	1519	303.8	152	6.8	0.0	0.0	0.00	DU	0.00
GSA0561S	719	Burn Pit	Bore 38	No. 2	1519	303.8	152	6.8	0.3	-1.1	-0.02	U+d	-0.18
GSA0574S	1359	Burn Pit	Bore 38	No. 3	1519	303.8	152	6.8	-1.0	3.3	0.06	DU	0.14
GSA0548S	670	Burn Pit	Bore 38	No. 4	1519	303.8	152	6.8	-0.1	0.2	0.00	DU	0.01
GSA0563S	287	Burn Pit	Bore 38	No. 5	1519	303.8	152	6.8	4.7	2.5	0.05	U+d	0.97
GSA0549S	620	Burn Pit	Bore 38	No. 6	1519	303.8	152	6.8	4.2	-1.4	-0.03	U+d	0.14
GSA0558S	1177	Burn Pit	Bore 39	No. 1	1521	296.1	144.6	7.6	-27.9	88.9	1.69	DU	3.73
GSA0562S	404	Burn Pit	Bore 39	No. 2	1521	296.1	144.6	7.6	-24.7	78.6	1.50	DU	3.30
GSA0557S	1213	Burn Pit	Bore 39	No. 3	1521	296.1	144.6	7.6	2.2	14.3	0.27	U+d	3.11
GSA0585S	486	Burn Pit	Bore 39	No. 4	1521	296.1	144.6	7.6	5.9	7.7	0.15	U+d	2.14
GSA0582S	246	Burn Pit	Bore 39	No. 5	1521	296.1	144.6	7.6	-3.1	9.8	0.19	DU	0.41
GSA0560S	1302	Burn Pit	Bore 40	No. 1	1512	289.5	119.8	8.1	-25.6	81.5	1.55	DU	3.42
GSA0579S	1660	Burn Pit	Bore 40	No. 2	1512	289.5	119.8	8.1	-0.7	2.3	0.04	DU	0.10

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	\ Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Concentration - pCi/g Sand Corrected Th-234	Concentration - pCi/g Estimated U-235	Material	Fraction of Limit
GSA0559S	1401	Burn Pit	Bore 40	No. 3	1512	289.5	119.8	8.1	1.0	6.2	0.12	DU	0.26
GSA0566S	1127	Burn Pit	Bore 40	No. 4	1512	289.5	119.8	8.1	2.4	-0.4	-0.01	U+d	0.17
GSA0571S	773	Burn Pit	Bore 40	No. 5	1512	289.5	119.8	8.1	3.4	2.4	0.05	U+d	0.83
GSA0594S	1065	Burn Pit	Bore 41	No. 1	1518	317.3	164.1	7.5	-54.2	172.6	3.29	DU	7.25
GSA0573S	1379	Burn Pit	Bore 41	No. 2	1518	317.3	164.1	7.5	0.0	-0.1	0.00	U+d	-0.02
GSA0577S	512	Burn Pit	Bore 41	No. 2	1518	317.3	164.1	7.5	0.6	-1.9	-0.04	U+d	-0.32
GSA0602S	1255	Burn Pit	Bore 41	No. 3	1518	317.3	164.1	7.5	0.1	-0.2	0.00	U+d	-0.04
GSA0575S	991	Burn Pit	Bore 41	No. 4	1518	317.3	164.1	7.5	0.2	-0.5	-0.01	U+d	-0.09
GSA0569S	897	Burn Pit	Bore 41	No. 5	1518	317.3	164.1	7.5	0.2	-0.7	-0.01	U+d	-0.12
GSA0565S	934	Burn Pit	Bore 41	No. 6	1518	317.3	164.1	7.5	0.2	-0.6	-0.01	U+d	-0.11
GSA0592S	261	Burn Pit	Bore 41	No. 7	1518	317.3	164.1	7.5	1.4	-4.5	-0.09	U+d	-0.77
GSA0568S	1125	Burn Pit	Bore 42	No. 1	1517	327.7	132.9	7.8	0.1	-0.4	-0.01	U+d	-0.06
GSA0570S	375	Burn Pit	Bore 42	No. 2	1517	327.7	132.9	7.8	7.0	-1.1	-0.02	U+d	0.47
GSA0567S	1372	Burn Pit	Bore 42	No. 3	1517	327.7	132.9	7.8	0.0	-0.1	0.00	U+d	-0.03
GSA0564S	1578	Burn Pit	Bore 42	No. 4	1517	327.7	132.9	7.8	0.0	0.0	0.00	U+d	0.00

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0597S	259	Burn Pit	Bore 42	No. 5	1517	327.7	132.9	7.8	8.4	-4.6	-0.09	U+d	-0.08
GSA0583S	1181	Burn Pit	Bore 43	No. 1	1516	322.8	109.2	8.6	-1.4	24.6	0.47	DU	1.03
GSA0589S	634	Burn Pit	Bore 43	No. 2	1516	322.8	109.2	8.6	3.0	14.3	0.27	U+d	3.18
GSA0595S	848	Burn Pit	Bore 43	No. 3	1516	322.8	109.2	8.6	2.1	13.1	0.25	U+d	2.86
GSA0587S	1056	Burn Pit	Bore 43	No. 4	1516	322.8	109.2	8.6	4.4	-0.5	-0.01	U+d	0.35
GSA0612S	235	Burn Pit	Bore 43	No. 5	1516	322.8	109.2	8.6	11.4	-0.4	-0.01	U+d	1.06
GSA0581S	1486	Burn Pit	Bore 44	No. 1	1510	279.5	101.1	8.8	2.2	6.8	0.13	U+d	1.59
GSA0598S	1727	Burn Pit	Bore 44	No. 2	1510	279.5	101.1	8.8	0.0	0.1	0.00	DU	0.00
GSA0586S	1551	Burn Pit	Bore 44	No. 3	1510	279.5	101.1	8.8	0.0	0.0	0.00	U+d	0.00
GSA0596S	643	Burn Pit	Bore 44	No. 4	1510	279.5	101.1	8.8	5.9	-1.3	-0.03	U+d	0.32
GSA0593S	1230	Burn Pit	Bore 44	No. 5	1510	279.5	101.1	8.8	-2.4	7.7	0.15	DU	0.32
GSA0591S	219	Burn Pit	Bore 44	No. 6	1510	279.5	101.1	8.8	-0.4	1.3	0.02	DU	0.05
GSA0611S	356.1	Burn Pit	Pit Bottom 1	No. 1	1522	300.1	139	8.3	-33.0	104.9	2.00	DU	4.41
GSA0683S	880.8	Burn Pit	Pit Bottom 2	No. 1	1523	298.7	140.4	8.3	-30.4	129.3	2.46	DU	5.43
GSA0614S	287.3	Burn Pit	Pit Bottom 2	No. 2	1523	298.7	140.4	8.3	7.9	10.2	0.19	U+d	2.84

Table C-5
Soil Bore Samples
Gamma Spectroscopy Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	\ Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0588S	513	Burn Pit	Pit Bottom 3	No. 1	1524	297.5	135.5	8.4	-19.0	60.5	1.15	DU	2.54
GSA0608S	358.1	Burn Pit	Pit Bottom 4	No. 1	1525	300.1	134.1	8.4	7.0	21.4	0.41	U+d	5.02
GSA0613S	106.1	Burn Pit	Pit Bottom 4	No. 2	1525	300.1	134.1	8.4	-24.7	78.6	1.50	DU	3.30
GSA0600S	853	Burn Pit	Pit Bottom 12	No. 1					-47.8	152.2	2.90	DU	6.39
GSA0572S	376	Burn Pit	Pit Wall 5	No. 1	1526	301	135.2	8.4	-36.5	116.1	2.21	DU	4.88
GSA0578S	671	Burn Pit	Pit Wall 8	No. 1	1529	295.9	137	8.4	0.4	-1.2	-0.02	U+d	-0.21
GSA0590S	290	Burn Pit	Pit Wall 9	No. 1	1530	296.7	139.1	8.4	-15.4	91.6	1.75	DU	3.85
GSA0609S	542.5	Burn Pit	Pit Wall10	No. 1	1531	298.9	140	8.3	-22.1	70.4	1.34	DU	2.96
GSA0610S	550	Burn Pit	Pit Wall11	No. 1	1532	301	139.2	8.3	-17.1	54.3	1.03	DU	2.28

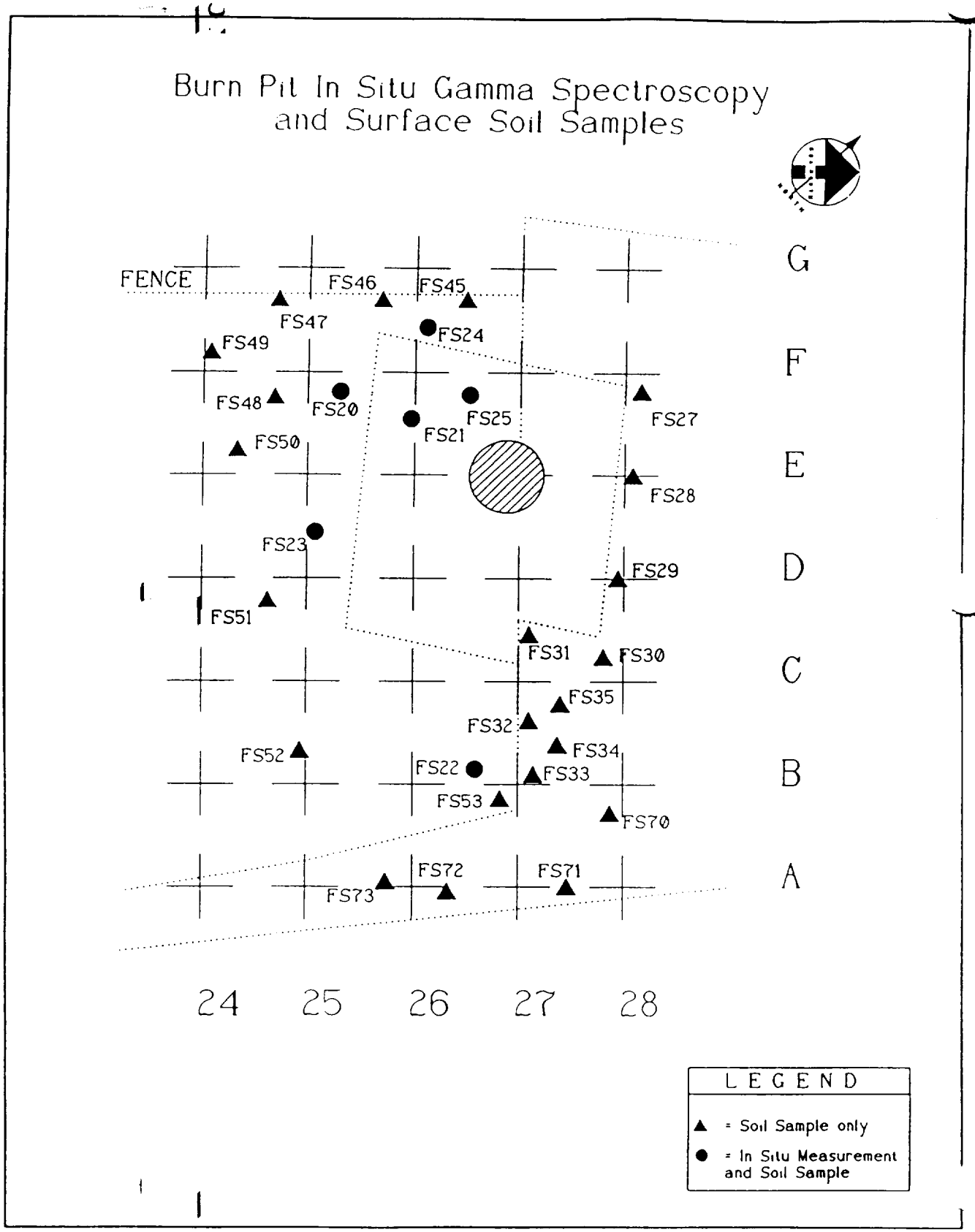


Figure C-24. Burn pit locations for in situ measurements and soil samples

Table C-6
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(pCi/g)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g: Estimated Ra-226	Concentration - pCi/g: Sand Corrected Th-234	Concentration - pCi/g: Estimated U-235	Material	Fraction of Limit
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8	-2.1	6.7	0.13	DU	0.28
GSA0687S	1690	Burn Pit		FS-21	1509	274.8	95.8	9	3.2	11.4	0.22	U+d	2.63
GSA0689S	1671	Burn Pit		FS-22	1503	192.6	226.2	7.8	0.6	24.9	0.48	U+d	5.10
GSA0691S	1636	Burn Pit		FS-23	1505	230.8	98.6	8.7	2.5	14.5	0.28	U+d	3.19
GSA0693S	1281	Burn Pit		FS-24	1537	325.9	77.2	7.9	-26.5	84.4	1.61	DU	3.54
GSA0695S	1218	Burn Pit		FS-25	1515	311	120.4	7.8	2.0	11.8	0.23	U+d	2.59
GSA0764S	962.2	Burn Pit	Surface Soil	FS-27	1712	369.2	148.3	7.4	4.0	7.9	0.15	U+d	1.99
GSA0762S	896.3	Burn Pit	Surface Soil	FS-28	1713	335.6	177.8	7.7	-1.5	4.8	0.09	DU	0.20
GSA0760S	1097	Burn Pit	Surface Soil	FS-29	1714	302.8	213.7	7.9	2.0	4.2	0.08	U+d	1.05
GSA0758S	882	Burn Pit	Surface Soil	FS-30	1715	270.9	231.7	7.7	-1.7	5.5	0.11	DU	0.23
GSA0752S	1253	Burn Pit	Surface Soil	FS-31	1716	246.9	203.3	8.1	1.4	32.3	0.61	U+d	6.65
GSA0750S	1242	Burn Pit	Surface Soil	FS-32	1717	219.5	231.4	8	1.8	16.1	0.31	U+d	3.43

Table C-6
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Concentration - pCi/g Sand Corrected Th-234	Concentration - pCi/g Estimated U-235	Material	Fraction of Limit
GSA0748S	997	Burn Pit	Surface Soil	FS-33	1718	204.5	248.8	8.1	-3.0	9.5	0.18	DU	0.40
GSA0754S	1007	Burn Pit	Surface Soil	FS-34	1719	223	244.8	8	0.2	-0.5	-0.01	U+d	-0.09
GSA0756S	1289	Burn Pit	Surface Soil	FS-35	1720	232.7	233.7	8.1	2.2	7.8	0.15	U+d	1.79
GSA0774S	829.9	Burn Pit	Surface Soil	FS-45	1711	338	58.4	7.5	-1.0	3.2	0.06	DU	0.13
GSA0772S	584	Burn Pit	Surface Soil	FS-46	1710	313.6	37.1	7.7	-3.1	9.7	0.19	DU	0.41
GSA0770S	923	Burn Pit	Surface Soil	FS-47	1709	281.2	5.8	7.7	0.2	-0.6	-0.01	U+d	-0.11
GSA0767S	1839	Burn Pit	Surface Soil	FS-48	1708	239.4	35.9	8.4	0.0	0.1	0.00	DU	0.00
GSA0768S	1743	Burn Pit	Surface Soil	FS-49	1707	231.1	8.1	8.3	-0.9	2.9	0.05	DU	0.12
GSA0776S	1393	Burn Pit	Surface Soil	FS-50	1706	209.8	51.2	8.3	0.0	-0.1	0.00	U+d	-0.02
GSA0778S	1647	Burn Pit	Surface Soil	FS-51	1705	171.6	114.6	8.7	0.0	0.0	0.00	DU	0.00
GSA0780S	1865	Burn Pit	Surface Soil	FS-52	1704	138.1	172.1	8.1	2.2	4.9	0.09	U+d	1.20

Table C-6
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
									Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0782S	1707	Burn Pit	Surface Soil	FS-53	1703	190.8	246.4	7.8	-1.2	3.9	0.07	DU	0.16
GSA0816S	652	AreaA25_A28	Surface Soil	FS-70					0.4	-1.3	-0.02	U+d	-0.22
GSA0818S	1011	Area A25_A28	Surface Soil	FS-71					2.1	26.0	0.49	DU	1.09
GSA0820S	1032	Area A25_A28	Surface Soil	FS-72					-1.2	4.0	0.08	DU	0.17
GSA0822S	890	Area A25_A28	Surface Soil	FS-73					3.5	15.3	0.29	U+d	3.44

Table C-7
Burn Pit - Bulk Soil Samples
Gamma Spectroscopy Sample Analyses Results
(pCi/g)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g: Estimated Ra-226	Concentration - pCi/g: Sand Corrected Th-234	Concentration - pCi/g: Estimated U-235	Material	Fraction of Limit
GSA0706DD	1780	Burn Pit	Sample #1	Lower Coarse	1508	279.5	93.3	8.8	0.0	0.1	0.00	DU	0.00
GSA0708DD	1702	Burn Pit	Sample #1	Lower Fines	1508	279.5	93.3	8.8	0.0	0.1	0.00	DU	0.00
GSA0707DD	1901	Burn Pit	Sample #1	Lower Middlings	1508	279.5	93.3	8.8	0.0	0.1	0.00	DU	0.01
GSA0727S	2.5	Burn Pit	Sample #1	Upper	1508	279.5	93.3	8.8	-542.4	1725.8	32.87	DU	72.48
GSA0703DD	1685	Burn Pit	Sample #1	Upper Coarse	1508	279.5	93.3	8.8	0.0	0.0	0.00	DU	0.00
GSA0705DD	1481	Burn Pit	Sample #1	Upper Fines	1508	279.5	93.3	8.8	2.0	8.2	0.16	U+d	1.85
GSA0704DD	1754	Burn Pit	Sample #1	Upper Middlings	1508	279.5	93.3	8.8	0.0	0.1	0.00	DU	0.00
GSA0712DD	1800	Burn Pit	Sample #2	Lower Coarse	1507	266.5	66.4	7.9	6.0	0.1	0.00	U+d	0.62
GSA0714DD	1738	Burn Pit	Sample #2	Lower Fines	1507	266.5	66.4	7.9	2.9	6.8	0.13	U+d	1.66
GSA0713DD	1936	Burn Pit	Sample #2	Lower Middlings	1507	266.5	66.4	7.9	1.3	2.6	0.05	U+d	0.65
GSA0709DD	1695	Burn Pit	Sample #2	Upper Coarse	1507	266.5	66.4	7.9	3.8	0.0	0.00	U+d	0.39
GSA0711DD	1602	Burn Pit	Sample #2	Upper Fines	1507	266.5	66.4	7.9	2.5	6.1	0.12	U+d	1.48

Table C-7
Burn Pit - Bulk Soil Samples
Gamma Spectroscopy Sample Analyses Results
(pCi/g)
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0710DD	1914	Burn Pit	Sample #2	Upper Middlings	1507	266.5	66.4	7.9	-0.9	2.9	0.06	DU	0.12
GSA0718DD	1734	Burn Pit	Sample #3	Lower Coarse	1504	191.9	230.9	7.4	4.0	0.1	0.00	U+d	0.42
GSA0720DD	1721	Burn Pit	Sample #3	Lower Fines	1504	191.9	230.9	7.4	0.0	0.1	0.00	DU	0.00
GSA0719DD	1400	Burn Pit	Sample #3	Lower Middlings	1504	191.9	230.9	7.4	0.0	-0.1	0.00	U+d	-0.02
GSA0715S	1022	Burn Pit	Sample #3	Upper Coarse	1504	191.9	230.9	7.4	0.2	-0.5	-0.01	U+d	-0.09
GSA0717DD	1837	Burn Pit	Sample #3	Upper Fines	1504	191.9	230.9	7.4	-38.1	121.1	2.31	DU	5.09
GSA0716S	1690	Burn Pit	Sample #3	Upper Middlings	1504	191.9	230.9	7.4	3.6	4.7	0.09	U+d	1.32

Table C-8
Burn Pit
In Situ Gamma Spectroscopy Results
Fraction of Limit

Location Code	Material	Calculated Results		
		Concentration (pCi/g)	2 sigma Error (pCi/g)	Fraction of Limit
FS-20	U+d	10.3	3.7	1.03
FS-21	DU	10.5	2.9	0.30
FS-22	DU	13.6	3.6	0.39
FS-23	DU	13.1	3.6	0.38
FS-24	DU	18.7	4.7	0.53
FS-25	DU	12.3	3.3	0.35

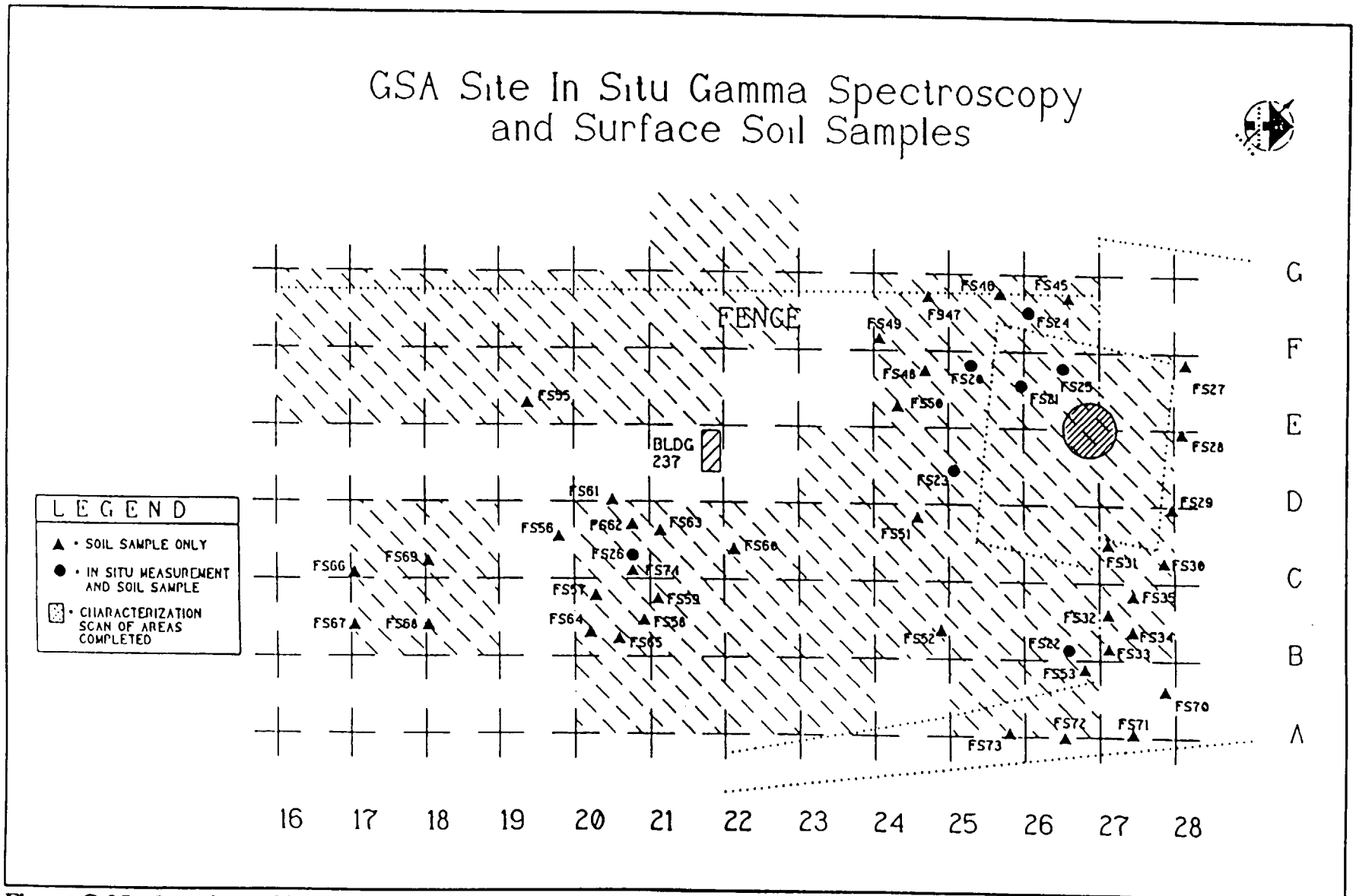


Figure C-25. Locations of in situ and soil samples in the Burn Pit and Clinker Areas

Table C-9
Clinker Area - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
Fraction of Limit

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	Concentration - pCi/g			Material	Fraction of Limit
						Massachusetts Grid			Estimated Ra-226	Sand Corrected Th-234	Estimated U-235		
GSA0697S	1077	Clinker Area	Surface Soil	FS-26					1.9	26.6	0.51	U+d	5.55
GSA0786S	1387	Clinker Area	Surface Soil	FS-55					5.8	-0.1	0.00	U+d	0.55
GSA0788S	2027	Clinker Area	Surface Soil	FS-56					-0.1	0.2	0.00	DU	0.01
GSA0790S	1657	Clinker Area	Surface Soil	FS-57					2.5	9.8	0.19	U+d	2.23
GSA0792S	1535	Clinker Area	Surface Soil	FS-58					0.0	0.0	0.00	U+d	-0.01
GSA0794S	1538	Clinker Area	Surface Soil	FS-59					0.0	0.0	0.00	U+d	-0.01
GSA0796S	1378	Clinker Area	Surface Soil	FS-60					0.0	-0.1	0.00	U+d	-0.02
GSA0798S	1754	Clinker Area	Surface Soil	FS-61					0.0	0.1	0.00	DU	0.00
GSA0800S	1225	Clinker Area	Surface Soil	FS-62					5.0	19.5	0.37	U+d	4.43
GSA0802S	1626	Clinker Area	Surface Soil	FS-63					0.0	20.1	0.80	DU	0.85

Table C-9
Clinker Area - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
Fraction of Limit
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Sand Corrected Th-234	Estimated U-235	Material	Fraction of Limit
GSA0697S	1077	Clinker Area	Surface Soil	FS-26					1.9	26.6	0.51	U+d	5.55
GSA0804S	1730	Clinker Area	Surface Soil	FS-64					3.0	36.9	0.97	U+d	7.78
GSA0806S	1471	Clinker Area	Surface Soil	FS-65					7.9	25.7	0.49	U+d	5.98
GSA0808S	1612	Clinker Area	Surface Soil	FS-66					4.8	0.0	0.00	U+d	0.48
GSA0810S	1396	Clinker Area	Surface Soil	FS-67					0.0	-0.1	0.00	U+d	-0.02
GSA0812S	1396	Clinker Area	Surface Soil	FS-68					0.0	-0.1	0.00	U+d	-0.02
GSA0814S	1396	Clinker Area	SURFAC E SOIL	FS-69					0.0	-0.1	0.00	U+d	-0.02

Table C-10
Clinker Area
In Situ Gamma Spectroscopy Results
Fraction of Limit

Location Code	Material	Calculated Results		
		Concentration (pCi/g)	2 Sigma Error (pCi/g)	Fraction of Limit
FS-26	DU	78.65	17.53	2.25

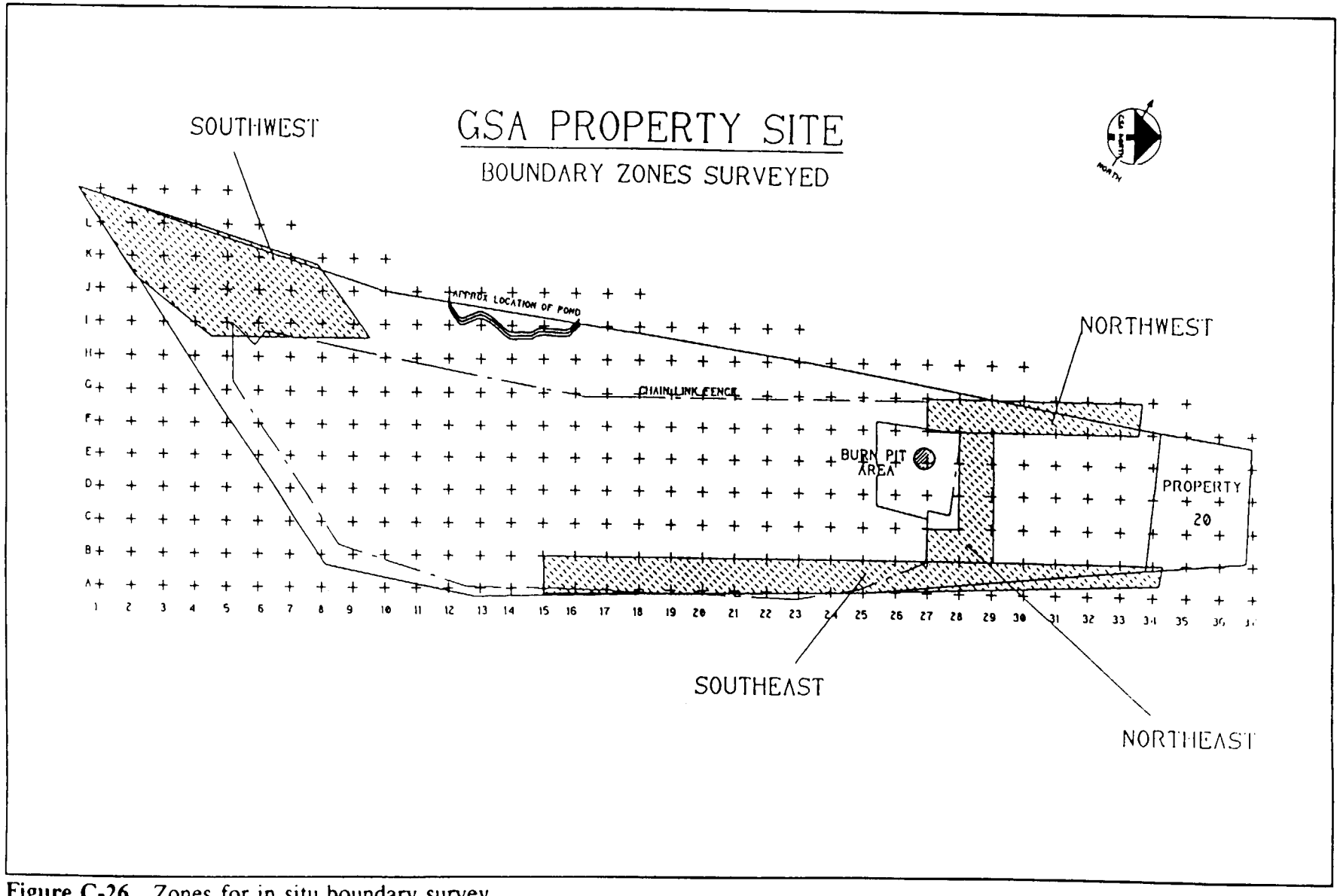


Figure C-26. Zones for in situ boundary survey

Table C-11
GSA Boundary
In Situ Gamma Spectroscopy Survey - Northeast
Fraction of Limit
Concentration (pCi/g)

Sample ID, Location			Material	Sample Conc. (pCi/g)	2-sigma Error (pCi/g)	Fraction of Limit
ID1	ID2	ID3				
A	27		DU	0.0	0.0	0.00
B	27		U+d	8.7	3.2	0.87
B	27	C1	DU	2.5	2.2	0.07
C	27		DU	15.5	3.5	0.44
C	27	C1	DU	1.9	2.0	0.05
A	28		DU	0.0	0.0	0.00
B	28		DU	0.0	0.0	0.00
B	28	C1	DU	0.0	0.0	0.00
C	28		DU	2.5	2.0	0.07
C	28	C1	U+d	2.1	1.3	0.21
D	28		DU	6.0	2.1	0.17
D	28	C1	U+d	4.4	1.8	0.44
A	29		U+d	1.5	1.1	0.15
B	29		DU	0.0	0.0	0.00
C	29		U+d	5.4	3.4	0.54

Table C-12
GSA Boundary
In Situ Gamma Spectroscopy Survey - Northwest
Fraction of Limit
Concentration (pCi/g)

Sample ID, Location			Material	Sample Conc. (pCi/g)	2-sigma Error (pCi/g)	Fraction of Limit
ID1	ID2	ID3				
F	31		U+d	1.8	1.2	0.18
F	32	C1	DU	0.0	0.0	0.00
F	32	C2	DU	1.6	2.4	0.05
F	32		U+d	1.8	1.1	0.18
F	33	C1	U+d	2.1	1.4	0.21
G	28		DU	0.0	0.0	0.00
G	31	C1	DU	0.0	0.0	0.00

Table C-13
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southeast
Fraction of Limit
Concentration (pCi/g)

Sample ID, Location			Material	Sample Conc. (pCi/g)	2-sigma Error (pCi/g)	Fraction of Limit
ID1	ID2	ID3				
B	15		DU	2.0	2.1	0.06
B	15	C1	U+d	2.6	1.4	0.26
A	16		DU	0.0	0.0	0.00
B	16		U+d	4.1	3.2	0.41
B	16	C1	DU	0.2	2.7	0.00
A	17		DU	0.0	0.0	0.00
B	17		U+d	4.1	2.8	0.41
B	17	C1	DU	0.3	1.8	0.01
A	18		U+d	2.1	1.0	0.21
B	18		U+d	1.2	1.1	0.12
B	18	C1	U+d	2.2	1.3	0.22
A	19		DU	0.0	0.0	0.00
B	19		DU	0.0	0.0	0.00
B	19	C1	DU	4.3	3.0	0.12
A	20		U+d	2.1	1.3	0.21
B	20		U+d	4.1	3.0	0.41
B	20	C1	DU	4.2	2.4	0.12
A	21		DU	0.0	0.0	0.00
B	21		DU	0.0	0.0	0.00
B	21	C1	U+d	1.4	1.1	0.14
A	22		DU	-0.3	-2.2	-0.01
B	22		U+d	1.3	1.1	0.13
B	22	C1	DU	0.0	0.0	0.00
A	23		DU	0.0	0.0	0.00
B	23		DU	0.0	0.0	0.00
B	23	C1	DU	0.0	0.0	0.00
A	24		U+d	1.3	1.1	0.13
B	24		U+d	1.9	1.0	0.19
B	24	C1	DU	0.0	0.0	0.00
A	25		DU	3.6	2.8	0.10

Table C-13
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southeast
Fraction of Limit
Concentration (pCi/g)
(continued)

Sample ID, Location			Material	Sample Conc. (pCi/g)	2-sigma Error (pCi/g)	Fraction of Limit
ID1	ID2	ID3				
B	25		DU	0.0	0.0	0.00
B	25	C1	DU	3.8	2.5	0.11
A	26		DU	0.0	0.0	0.00
B	26		U+d	9.9	3.5	0.99
B	26	C1	U+d	1.4	0.9	0.14
A	27		DU	0.0	0.0	0.00
B	27		U+d	8.7	3.2	0.87
B	27	C1	DU	2.5	2.2	0.07
A	28		DU	0.0	0.0	0.00
B	28		DU	0.0	0.0	0.00
B	28	C1	DU	0.0	0.0	0.00
A	29		U+d	1.5	1.1	0.15
B	29		DU	0.0	0.0	0.00
B	29	C1	DU	0.0	0.0	0.00
B	30		DU	0.0	0.0	0.00
B	30	C1	DU	0.0	0.0	0.00
B	31		U+d	6.9	3.9	0.69
B	31	C1	DU	0.0	0.0	0.00
B	32		DU	0.0	0.0	0.00
B	32	C1	U+d	1.8	1.3	0.18
B	33		DU	0.0	0.0	0.00
B	33	C1	U+d	7.7	3.6	0.77
C	33	C1	DU	4.3	3.8	0.12
B	34		U+d	1.3	1.0	0.13
B	34	C1	DU	0.0	0.0	0.00

Table C-14
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southwest
Fraction of Limit
Concentration (pCi/g)

Sample ID, Location			Material	Sample Conc. (pCi/g)	2-sigma Error (pCi/g)	Fraction of Limit
ID1	ID2	ID3				
I	5		DU	0.0	0.0	0.00
I	6		DU	0.0	0.0	0.00
I	7		U+d	1.3	1.2	0.13
I	7	C1	DU	0.0	0.0	0.00
I	8		DU	0.0	0.0	0.00
I	8	C1	U+d	1.8	1.5	0.18
I	9		U+d	1.4	1.3	0.14
I	9	C1	U+d	2.5	1.3	0.25
J	3		DU	2.6	2.5	0.07
J	3	C1	DU	0.0	0.0	0.00
J	4		DU	0.0	0.0	0.00
J	4	C1	DU	0.0	0.0	0.00
J	5		U+d	2.0	1.4	0.20
J	6		U+d	1.6	1.1	0.16
J	6	C1	DU	0.0	0.0	0.00
J	7	C1	DU	0.0	0.0	0.00
K	3		DU	0.0	0.0	0.00
K	3	C1	DU	0.0	0.0	0.00
K	4		DU	0.0	0.0	0.00

Table C-15
Windborne - Soil Samples
Gamma Spectroscopy Sample Analyses
(pCi/g)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g: Estimated Ra-226	Concentration - pCi/g: Sand Corrected Th-234	Concentration - pCi/g: Estimated U-235	Material	Fraction of Limit
GSA0584S	834	East of Greenough	Windborne 1	No. 1	1540	110.8	396.7	11.8	0.3	-0.8	-0.02	U+d	-0.14
GSA0601S	1178	East of Greenough	Windborne 2	No. 1	1539	195.4	643.5	11.5	0.1	-0.3	-0.01	U+d	-0.05
GSA0603S	1060	East of Greenough	Windborne 2	No. 2	1539	195.4	643.5	11.5	0.1	-0.4	-0.01	U+d	-0.08
GSA0604S	982	East of Greenough	Windborne 3	No. 1	1565	291.7	541.2	10.8	0.2	-0.6	-0.01	U+d	-0.09
GSA0599S	949	East of Greenough	Windborne 3	No. 2	1565	291.7	541.2	10.8	0.2	-0.6	-0.01	U+d	-0.10
GSA0559S	1181	East of Greenough	Windborne 4	No. 1	1564	372.4	606.4	11	0.1	-0.3	-0.01	U+d	-0.05
GSA0607S	967.8	East of Greenough	Windborne 4	No. 2	1564	372.4	606.4	11	0.2	-0.6	-0.01	U+d	-0.10
GSA0605S	797	East of Greenough	Windborne 5	No. 1	1563	439.2	663.9	5.4	0.3	-0.9	-0.02	U+d	-0.15
GSA0606S	673.7	East of Greenough	Windborne 5	No. 2	1563	439.2	663.9	5.4	0.4	-1.2	-0.02	U+d	-0.21

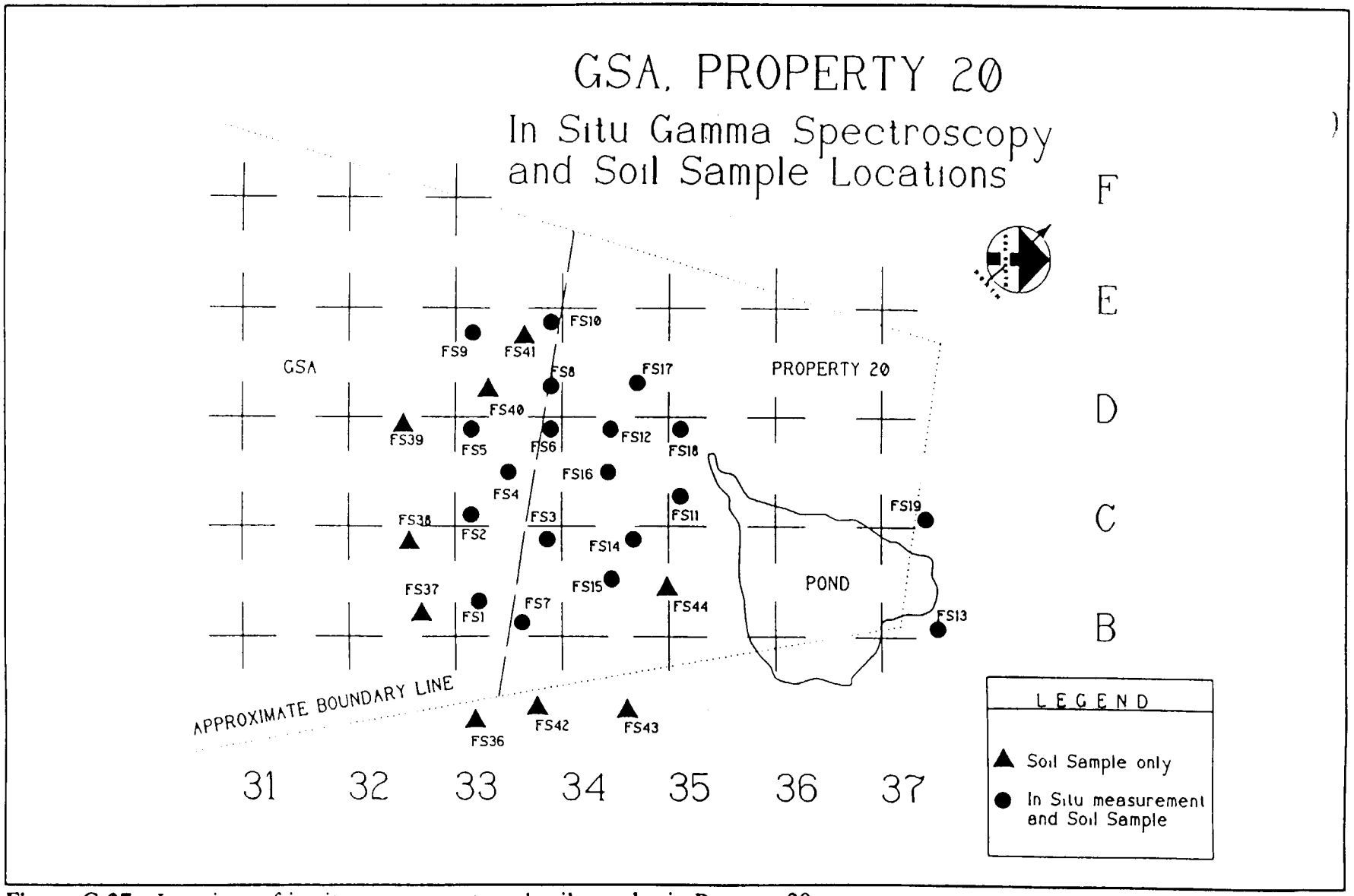


Figure C-27. Locations of in situ meaurements and soil samples in Property 20

Table C-16
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
Fraction of Limit

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Concentration - pCi/g Sand Corrected Th-234	Concentration - pCi/g Estimated U-235	Material	Fraction of Limit
GSA0616S	1541	Area 20		FS-01	1547	438.4	445.5	10.1	15.6	13.0	0.25	U+d	4.18
GSA0618S	1335	Area 20		FS-02	1542	463.1	418	11.1	4.4	16.1	0.31	U+d	3.70
GSA0620S	1446	Area 20		FS-03	1545	484.2	444.3	10	5.7	7.6	0.14	U+d	2.11
GSA0624S	1632	Area 20		FS-04	1543	482.9	419.1	10.8	4.6	18.2	0.35	U+d	4.14
GSA0622S	1415	Area 20		FS-05	1548	486.4	393.5	10.7	-30.9	98.4	1.87	DU	4.13
GSA0626S	1337	Area 20		FS-06	1550	506.2	417.9	10.4	3.5	4.7	0.09	U+d	1.31
GSA0664S	1459	Area 20		FS-07	1546	451.4	459.7	9.5	18.7	9.7	0.18	U+d	3.83
GSA0628S	1249	Area 20		FS-08	1549	531	394.7	9.8	3.4	7.3	0.14	U+d	1.81
GSA0630S	1040	Area 20		FS-09	1551	522.2	351.7	11.2	0.1	-0.5	-0.01	U+d	-0.08
GSA0632S	1371	Area 20		FS-10	1552	556.8	371.3	10.2	0.0	-0.1	0.00	U+d	-0.03

Table C-16
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
Fraction of Limit
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Concentration - pCi/g Sand Corrected Th-234	Concentration - pCi/g Estimated U-235	Material	Fraction of Limit
GSA0666S	1367	Area 20		FS-11	1557	543.4	473.4	8.3	0.0	-0.2	0.00	U+d	-0.03
GSA0682S	1434	Area 20		FS-13	1562	583.8	593.3	6.8	0.0	-0.1	0.00	U+d	-0.02
GSA0670S	1228	Area 20		FS-14	1558	510	473.1	9	0.1	-0.3	-0.01	U+d	-0.05
GSA0672S	1324	Area 20		FS-15	1559	490.9	496.5	8.6	7.0	3.7	0.07	U+d	1.45
GSA0674S	1313	Area 20		FS-16	1556	529.5	450.4	9.4	<3	-0.2	<.2	DU	-0.01
GSA0676S	1358	Area 20		FS-17	1554	565.9	424.8	9.6	0.0	-0.2	0.00	U+d	-0.03
GSA0678S	1172	Area 20		FS-18	1555	563.5	450.4	7.3	0.1	-0.3	-0.01	U+d	-0.05
GSA0680S	1043	Area 20		FS-19	1561	614.5	546.5	7.2	0.1	-0.5	-0.01	U+d	-0.08
GSA0736S	1098	Area 20	Surface Soil	FS-36	1722	420.4	467.5	7.9	0.1	-0.4	-0.01	U+d	-0.07
GSA0738S	1488	Area 20	Surface Soil	FS-37	1723	409.8	434.3	9.9	0.0	-0.1	0.00	U+d	-0.01

Table C-16
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
Fraction of Limit
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	Concentration - pCi/g Estimated Ra-226	Concentration - pCi/g Sand Corrected Th-234	Concentration - pCi/g Estimated U-235	Material	Fraction of Limit
GSA0746S	1155	Area 20	Surface Soil	FS-38	1728	437	402.2	10.6	0.1	-0.3	-0.01	U+d	-0.06
GSA0744S	1242	Area 20	Surface Soil	FS-39	1727	466.1	370.7	10.8	0.1	-0.3	0.00	U+d	-0.04
GSA0742S	1601	Area 20	Surface Soil	FS-40	1726	506.1	378.3	11	6.1	3.1	0.06	U+d	1.24
GSA0740S	1375	Area 20	Surface Soil	FS-41	1725	532.9	365.8	11.3	5.1	5.0	0.09	U+d	1.51
GSA0734S	1174	Area 20	Surface Soil	FS-42	1724	439.9	481.5	7.3	5.2	-0.3	-0.01	U+d	0.46
GSA0733S	1725	Area 20	Surface Soil	FS-43	1730	472.2	513.4	8	0.0	0.1	0.00	DU	0.00
GSA0731S	799.5	Area 20	Surface Soil	FS-44	1729	507.5	505.7	4.7	0.3	-0.9	-0.02	U+d	-0.15

Table C-17
Property 20
In Situ Gamma Spectroscopy Results
Fraction of Limit

Sample ID Code*	Material	Fraction of Limit
FS-01	U+d	1.50
FS-02	DU	0.30
FS-03	U+d	1.03
FS-04	U+d	2.30
FS-05	U+d	1.44
FS-06	DU	0.10
FS-07	DU	0.13
FS-08	DU	0
FS-09	DU	0
FS-10	DU	0
FS-11	DU	0
FS-12	U+d	0.13
FS-13	DU	0
FS-14	U+d	0.14
FS-15	U+d	0.15
FS-16	U+d	0.11
FS-17	DU	0.08
FS-18	DU	0
FS-19	DU	0

* See map for locations

Table C-18
Soil Sample Locations and Descriptors

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0584S	834	East of Greenough	Windborne 1	No. 1	1540	110.8	396.7	11.8
GSA0601S	1178	East of Greenough	Windborne 2	No. 1	1539	195.4	643.5	11.5
GSA0603S	1060	East of Greenough	Windborne 2	No. 2	1539	195.4	643.5	11.5
GSA0604S	982	East of Greenough	Windborne 3	No. 1	1565	291.7	541.2	10.8
GSA0599S	949	East of Greenough	Windborne 3	No. 2	1565	291.7	541.2	10.8
GSA0559S	1181	East of Greenough	Windborne 4	No. 1	1564	372.4	606.4	11
GSA0607S	967.8	East of Greenough	Windborne 4	No. 2	1564	372.4	606.4	11
GSA0605S	797	East of Greenough	Windborne 5	No. 1	1563	439.2	663.9	5.4
GSA0606S	673.7	East of Greenough	Windborne 5	No. 2	1563	439.2	663.9	5.4
GSA0616S	1541	GSA Area 20		FS-01	1547	438.4	445.5	10.1
GSA0618S	1335	GSA Area 20		FS-02	1542	463.1	418	11.1
GSA0620S	1446	GSA Area 20		FS-03	1545	484.2	444.3	10
GSA0624S	1632	GSA Area 20		FS-04	1543	482.9	419.1	10.8
GSA0622S	1415	GSA Area 20		FS-05	1548	486.4	393.5	10.7
GSA0626S	1337	GSA Area 20		FS-06	1550	506.2	417.9	10.4
GSA0664S	1459	GSA Area 20		FS-07	1546	451.4	459.7	9.5
GSA0628S	1249	GSA Area 20		FS-08	1549	531	394.7	9.8
GSA0630S	1040	GSA Area 20		FS-09	1551	522.2	351.7	11.2
GSA0632S	1371	GSA Area 20		FS-10	1552	556.8	371.3	10.2
GSA0666S	1367	GSA Area 20		FS-11	1557	543.4	473.4	8.3
GSA0682S	1434	GSA Area 20		FS-13	1562	583.8	593.3	6.8
GSA0670S	1228	GSA Area 20		FS-14	1558	510	473.1	9
GSA0672S	1324	GSA Area 20		FS-15	1559	490.9	496.5	8.6
GSA0674S	1313	GSA Area 20		FS-16	1556	529.5	450.4	9.4
GSA0676S	1358	GSA Area 20		FS-17	1554	565.9	424.8	9.6

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0678S	1172	GSA Area 20		FS-18	1555	563.5	450.4	7.3
GSA0680S	1043	GSA Area 20		FS-19	1561	614.5	546.5	7.2
GSA0518S	1201	Burn Pit	Bore 32	No. 1				
GSA0523S	328	Burn Pit	Bore 32	No. 2				
GSA0524S	943	Burn Pit	Bore 32	No. 3				
GSA0525S	261	Burn Pit	Bore 32	No. 4				
GSA0526S	160	Burn Pit	Bore 32	No. 5				
GSA0527S	132	Burn Pit	Bore 32	No. 6				
GSA0519S	1113	Burn Pit	Bore 33	No. 1	1513	292.7	125.2	7.6
GSA0522S	981	Burn Pit	Bore 33	No. 2	1513	292.7	125.2	7.6
GSA0520S	1638	Burn Pit	Bore 33	No. 3	1513	292.7	125.2	7.6
GSA0533S	635	Burn Pit	Bore 33	No. 4	1513	292.7	125.2	7.6
GSA0528S	134	Burn Pit	Bore 33	No. 5	1513	292.7	125.2	7.6
GSA0521S	950	Burn Pit	Bore 34	No. 1				
GSA0529S	395	Burn Pit	Bore 34	No. 2				
GSA0530S	751	Burn Pit	Bore 34	No. 3				
GSA0531S	524	Burn Pit	Bore 34	No. 4				
GSA0532S	282	Burn Pit	Bore 34	No. 5				
GSA0536S	1224	Burn Pit	Bore 35	No. 1	1520	297.7	142.6	7
GSA0535S	571	Burn Pit	Bore 35	No. 2	1520	297.7	142.6	7
GSA0534S	1431	Burn Pit	Bore 35	No. 3	1520	297.7	142.6	7
GSA0538S	616	Burn Pit	Bore 35	No. 4	1520	297.7	142.6	7
GSA0540S	144	Burn Pit	Bore 35	No. 5	1520	297.7	142.6	7
GSA0541S	1731	Burn Pit	Bore 36	No. 1				
GSA0537S	97	Burn Pit	Bore 36	No. 2				
GSA0542S	490	Burn Pit	Bore 36	No. 3				
GSA0543S	302	Burn Pit	Bore 36	No. 4				
GSA0539S	145	Burn Pit	Bore 36	No. 6				
GSA0544S	1267	Burn Pit	Bore 37	No. 1	1514	315.6	131.4	8

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0550S	548	Burn Pit	Bore 37	No. 2	1514	315.6	131.4	8
GSA0547S	1174	Burn Pit	Bore 37	No. 3	1514	315.6	131.4	8
GSA0546S	1068	Burn Pit	Bore 37	No. 4	1514	315.6	131.4	8
GSA0551S	467	Burn Pit	Bore 37	No. 5	1514	315.6	131.4	8
GSA0552S	860	Burn Pit	Bore 37	No. 5A	1514	315.6	131.4	8
GSA0545S	1658	Burn Pit	Bore 38	No. 1	1519	303.8	152	6.8
GSA0561S	719	Burn Pit	Bore 38	No. 2	1519	303.8	152	6.8
GSA0574S	1359	Burn Pit	Bore 38	No. 3	1519	303.8	152	6.8
GSA0548S	670	Burn Pit	Bore 38	No. 4	1519	303.8	152	6.8
GSA0563S	287	Burn Pit	Bore 38	No. 5	1519	303.8	152	6.8
GSA0549S	620	Burn Pit	Bore 38	No. 6	1519	303.8	152	6.8
GSA0558S	1177	Burn Pit	Bore 39	No. 1	1521	296.1	144.6	7.6
GSA0562S	404	Burn Pit	Bore 39	No. 2	1521	296.1	144.6	7.6
GSA0557S	1213	Burn Pit	Bore 39	No. 3	1521	296.1	144.6	7.6
GSA0585S	486	Burn Pit	Bore 39	No. 4	1521	296.1	144.6	7.6
GSA0582S	246	Burn Pit	Bore 39	No. 5	1521	296.1	144.6	7.6
GSA0560S	1302	Burn Pit	Bore 40	No. 1	1512	289.5	119.8	8.1
GSA0579S	1660	Burn Pit	Bore 40	No. 2	1512	289.5	119.8	8.1
GSA0559S	1401	Burn Pit	Bore 40	No. 3	1512	289.5	119.8	8.1
GSA0566S	1127	Burn Pit	Bore 40	No. 4	1512	289.5	119.8	8.1
GSA0571S	773	Burn Pit	Bore 40	No. 5	1512	289.5	119.8	8.1
GSA0594S	1065	Burn Pit	Bore 41	No. 1	1518	317.3	164.1	7.5
GSA0573S	1379	Burn Pit	Bore 41	No. 2	1518	317.3	164.1	7.5
GSA0577S	512	Burn Pit	Bore 41	No. 2	1518	317.3	164.1	7.5
GSA0602S	1255	Burn Pit	Bore 41	No. 3	1518	317.3	164.1	7.5
GSA0575S	991	Burn Pit	Bore 41	No. 4	1518	317.3	164.1	7.5
GSA0569S	897	Burn Pit	Bore 41	No. 5	1518	317.3	164.1	7.5
GSA0565S	934	Burn Pit	Bore 41	No. 6	1518	317.3	164.1	7.5
GSA0592S	261	Burn Pit	Bore 41	No. 7	1518	317.3	164.1	7.5

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0568S	1125	Burn Pit	Bore 42	No. 1	1517	327.7	132.9	7.8
GSA0570S	375	Burn Pit	Bore 42	No. 2	1517	327.7	132.9	7.8
GSA0567S	1372	Burn Pit	Bore 42	No. 3	1517	327.7	132.9	7.8
GSA0564S	1578	Burn Pit	Bore 42	No. 4	1517	327.7	132.9	7.8
GSA0597S	259	Burn Pit	Bore 42	No. 5	1517	327.7	132.9	7.8
GSA0583S	1181	Burn Pit	Bore 43	No. 1	1516	322.8	109.2	8.6
GSA0589S	634	Burn Pit	Bore 43	No. 2	1516	322.8	109.2	8.6
GSA0595S	848	Burn Pit	Bore 43	No. 3	1516	322.8	109.2	8.6
GSA0587S	1056	Burn Pit	Bore 43	No. 4	1516	322.8	109.2	8.6
GSA0612S	235	Burn Pit	Bore 43	No. 5	1516	322.8	109.2	8.6
GSA0581S	1486	Burn Pit	Bore 44	No. 1	1510	279.5	101.1	8.8
GSA0598S	1727	Burn Pit	Bore 44	No. 2	1510	279.5	101.1	8.8
GSA0586S	1551	Burn Pit	Bore 44	No. 3	1510	279.5	101.1	8.8
GSA0596S	643	Burn Pit	Bore 44	No. 4	1510	279.5	101.1	8.8
GSA0593S	1230	Burn Pit	Bore 44	No. 5	1510	279.5	101.1	8.8
GSA0591S	219	Burn Pit	Bore 44	No. 6	1510	279.5	101.1	8.8
GSA0555S	1000	Burn Pit	Burn Pit	Burn Pit water				
GSA0611S	356.1	Burn Pit	Pit Bottom 1	No. 1	1522	300.1	139	8.3
GSA0683S	880.8	Burn Pit	Pit Bottom 2	No. 1	1523	298.7	140.4	8.3
GSA0614S	287.3	Burn Pit	Pit Bottom 2	No. 2	1523	298.7	140.4	8.3
GSA0588S	513	Burn Pit	Pit Bottom 3	No. 1	1524	297.5	135.5	8.4
GSA0608S	358.1	Burn Pit	Pit Bottom 4	No. 1	1525	300.1	134.1	8.4
GSA0613S	106.1	Burn Pit	Pit Bottom 4	No. 2	1525	300.1	134.1	8.4
GSA0600S	853	Burn Pit	Pit Bottom 12	No. 1				
GSA0572S	376	Burn Pit	Pit Wall 5	No. 1	1526	301	135.2	8.4
GSA0578S	671	Burn Pit	Pit Wall 8	No. 1	1529	295.9	137	8.4
GSA0590S	290	Burn Pit	Pit Wall 9	No. 1	1530	296.7	139.1	8.4
GSA0609S	542.5	Burn Pit	Pit Wall 10	No. 1	1531	298.9	140	8.3

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0610S	550	Burn Pit	Pit Wall 11	No. 1	1532	301	139.2	8.3
GSA0553S	1000	Burn Pit	Well B-25	No. B-25-W-1	1511	310.1	87	8.5
GSA0554S	1000	Burn Pit	Well B-31	No. B-31-W-1				
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8
GSA0687S	1690	Burn Pit		FS-21	1509	274.8	95.8	9
GSA0689S	1671	Burn Pit		FS-22	1503	192.6	226.2	7.8
GSA0691S	1636	Burn Pit		FS-23	1505	230.8	98.6	8.7
GSA0693S	1281	Burn Pit		FS-24	1537	325.9	77.2	7.9
GSA0695S	1218	Burn Pit		FS-25	1515	311	120.4	7.8
GSA0697S	1077	Clinker Area		FS-26				
GSA0706DD	1780	Burn Pit	Bulk Sample #1	Lower Coarse	1508	279.5	93.3	8.8
GSA0708DD	1702	Burn Pit	Bulk Sample #1	Lower Fines	1508	279.5	93.3	8.8
GSA0707DD	1901	Burn Pit	Bulk Sample #1	Lower Middlings	1508	279.5	93.3	8.8
GSA0727S	2.5	Burn Pit	Bulk Sample #1	Upper	1508	279.5	93.3	8.8
GSA0703DD	1685	Burn Pit	Bulk Sample #1	Upper Coarse	1508	279.5	93.3	8.8
GSA0705DD	1481	Burn Pit	Bulk Sample #1	Upper Fines	1508	279.5	93.3	8.8
GSA0704DD	1754	Burn Pit	Bulk Sample #1	Upper Middlings	1508	279.5	93.3	8.8
GSA0712DD	1800	Burn Pit	Bulk Sample #2	Lower Coarse	1507	266.5	66.4	7.9
GSA0714DD	1738	Burn Pit	Bulk Sample #2	Lower Fines	1507	266.5	66.4	7.9
GSA0713DD	1936	Burn Pit	Bulk Sample #2	Lower Middlings	1507	266.5	66.4	7.9
GSA0709DD	1695	Burn Pit	Bulk Sample #2	Upper Coarse	1507	266.5	66.4	7.9

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0711DD	1602	Burn Pit	Bulk Sample #2	Upper Fines	1507	266.5	66.4	7.9
GSA0710DD	1914	Burn Pit	Bulk Sample #2	Upper Middlings	1507	266.5	66.4	7.9
GSA0718DD	1734	Burn Pit	Bulk Sample #3	Lower Coarse	1504	191.9	230.9	7.4
GSA0720DD	1721	Burn Pit	Bulk Sample #3	Lower Fines	1504	191.9	230.9	7.4
GSA0719DD	1400	Burn Pit	Bulk Sample #3	Lower Middlings	1504	191.9	230.9	7.4
GSA0715S	1022	Burn Pit	Bulk Sample #3	Upper Coarse	1504	191.9	230.9	7.4
GSA0717DD	1837	Burn Pit	Bulk Sample #3	Upper Fines	1504	191.9	230.9	7.4
GSA0716S	1690	Burn Pit	Bulk Sample #3	Upper Middlings	1504	191.9	230.9	7.4
GSA0764S	962.2	Burn Pit	Surface Soil	FS-27	1712	369.2	148.3	7.4
GSA0762S	896.3	Burn Pit	Surface Soil	FS-28	1713	335.6	177.8	7.7
GSA0760S	1097	Burn Pit	Surface Soil	FS-29	1714	302.8	213.7	7.9
GSA0758S	882	Burn Pit	Surface Soil	FS-30	1715	270.9	231.7	7.7
GSA0752S	1253	Burn Pit	Surface Soil	FS-31	1716	246.9	203.3	8.1
GSA0750S	1242	Burn Pit	Surface Soil	FS-32	1717	219.5	231.4	8
GSA0748S	997	Burn Pit	Surface Soil	FS-33	1718	204.5	248.8	8.1
GSA0754S	1007	Burn Pit	Surface Soil	FS-34	1719	223	244.8	8
GSA0756S	1289	Burn Pit	Surface Soil	FS-35	1720	232.7	233.7	8.1
GSA0736S	1098	GSA Area 20	Surface Soil	FS-36	1722	420.4	467.5	7.9
GSA0738S	1488	GSA Area 20	Surface Soil	FS-37	1723	409.8	434.3	9.9
GSA0746S	1155	GSA Area 20	Surface Soil	FS-38	1728	437	402.2	10.6
GSA0744S	1242	GSA Area 20	Surface Soil	FS-39	1727	466.1	370.7	10.8
GSA0742S	1601	GSA Area 20	Surface Soil	FS-40	1726	506.1	378.3	11
GSA0740S	1375	GSA Area 20	Surface Soil	FS-41	1725	532.9	365.8	11.3
GSA0734S	1174	GSA Area 20	Surface Soil	FS-42	1724	439.9	481.5	7.3
GSA0733S	1725	GSA Area 20	Surface Soil	FS-43	1730	472.2	513.4	8

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0731S	799.5	GSA Area 20	Surface Soil	FS-44	1729	507.5	505.7	4.7
GSA0774S	829.9	Burn Pit	Surface Soil	FS-45	1711	338	58.4	7.5
GSA0772S	584	Burn Pit	Surface Soil	FS-46	1710	313.6	37.1	7.7
GSA0770S	923	Burn Pit	Surface Soil	FS-47	1709	281.2	5.8	7.7
GSA0767S	1839	Burn Pit	Surface Soil	FS-48	1708	239.4	35.9	8.4
GSA0768S	1743	Burn Pit	Surface Soil	FS-49	1707	231.1	8.1	8.3
GSA0776S	1393	Burn Pit	Surface Soil	FS-50	1706	209.8	51.2	8.3
GSA0778S	1647	Burn Pit	Surface Soil	FS-51	1705	171.6	114.6	8.7
GSA0780S	1865	Burn Pit	Surface Soil	FS-52	1704	138.1	172.1	8.1
GSA0782S	1707	Burn Pit	Surface Soil	FS-53	1703	190.8	246.4	7.8
GSA0786S	1387	Clinker Area	Surface Soil	FS-55				
GSA0788S	2027	Clinker Area	Surface Soil	FS-56				
GSA0790S	1657	Clinker Area	Surface Soil	FS-57				
GSA0792S	1535	Clinker Area	Surface Soil	FS-58				
GSA0794S	1538	Clinker Area	Surface Soil	FS-59				
GSA0796S	1378	Clinker Area	Surface Soil	FS-60				
GSA0798S	1754	Clinker Area	Surface Soil	FS-61				
GSA0800S	1225	Clinker Area	Surface Soil	FS-62				
GSA0802S	1626	Clinker Area	Surface Soil	FS-63				
GSA0804S	1730	Clinker Area	Surface Soil	FS-64				
GSA0806S	1471	Clinker Area	Surface Soil	FS-65				
GSA0808S	1612	Clinker Area	Surface Soil	FS-66				
GSA0810S	1396	Clinker Area	Surface Soil	FS-67				
GSA0812S	1396	Clinker Area	Surface Soil	FS-68				
GSA0814S	1396	Clinker Area	Surface Soil	FS-69				
GSA0816S	652	Area A25_A28	Surface Soil	FS-70				
GSA0818S	1011	Area A25_A28	Surface Soil	FS-71				

Table C-18
Soil Sample Locations and Descriptors
(Continued)

Sample No.	Mass grams	Location	Bore Number	Sample Number	Survey Point	497000 + Northing	695000 + Easting	Elevation Feet
						Massachusetts Grid		
GSA0820S	1032	Area A25_A28	Surface Soil	FS-72				
GSA0822S	890	Area A25_A28	Surface Soil	FS-73				
GSA0824S	1523	ABB/BS106@ 12 FT	ABB BS-106	FS-74				

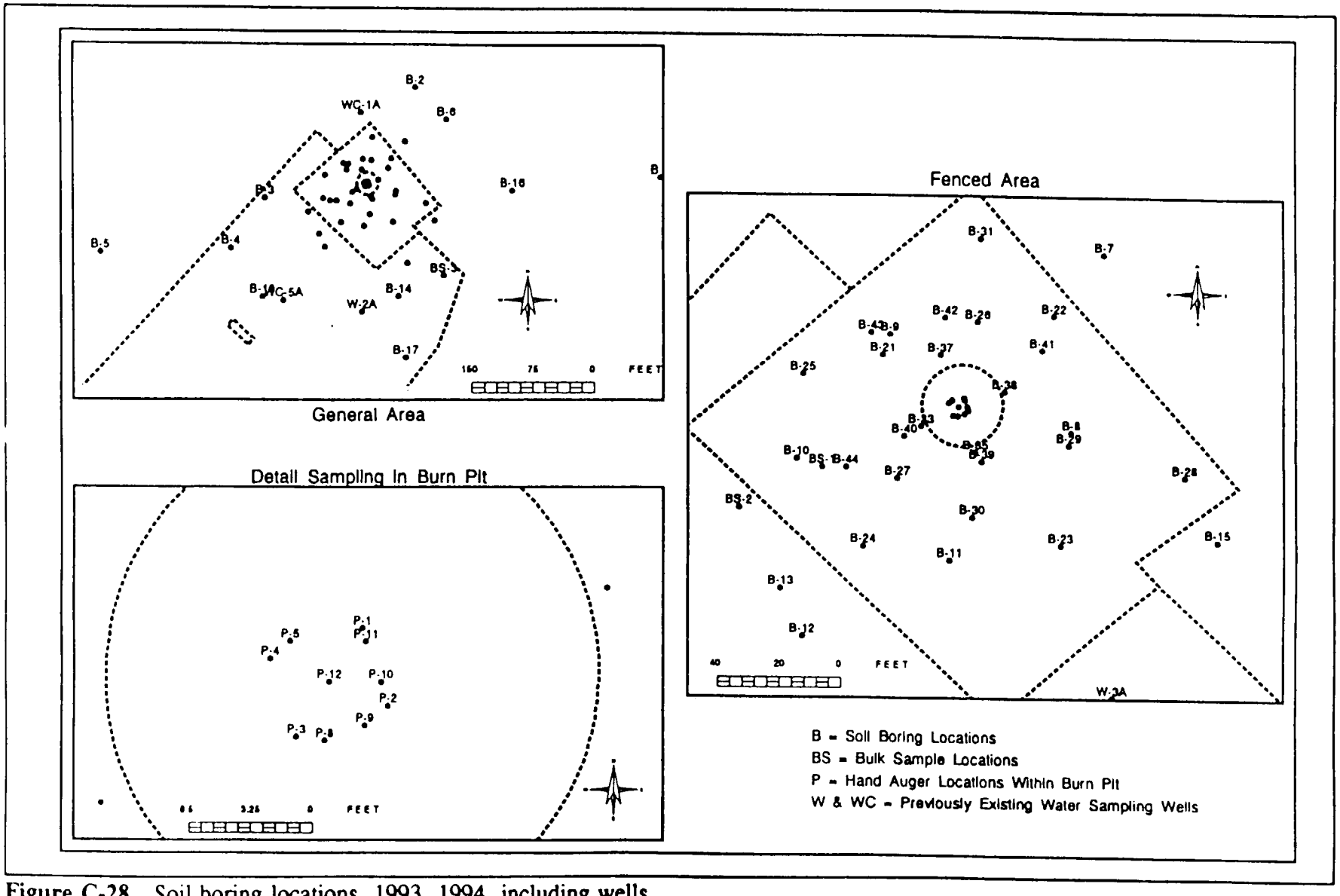


Figure C-28. Soil boring locations, 1993, 1994, including wells

Table C-19
GSA Burn Pit
Core Bore Sample Analysis Results
(pCi/g)

Core Number	Depth/ Type	K-40	Co-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234	U-235
B-21	0-1'	22.50*	0.36	0.30		0.79	0.77	0.88			0.96	55.78*	1.06
	1'-3'	16.01	0.14	0.23		0.60	0.68	0.73		8.39*	0.91	21.73*	
	3'-5'	21.12		0.24		0.45	0.60	0.62		3.13*	0.66	4.20*	
	5'-7'	20.99		0.28		0.79	0.71	0.80					
	trans	301.44*		2.06*		5.45*	4.01	3.91*		15.27*	5.43		
	silt	70.88*		0.34		1.61*	1.10	0.86					
	8' peat	298.56*		2.04*	4.21*	4.73*	3.02*	3.31*		9.64*	4.92*		
B-22	0-1'	33.61*		0.61*		1.14	1.26*	1.59*					
	1'-3'	52.29*		0.83*		1.54*	1.61*	1.78*					
	3'-5'	10.67		0.29		0.75	0.84	0.66					
	5'-7'	18.98		0.22		0.65	0.67	0.59					
	silt	42.71*		0.45*		0.87		0.78					
	u. peat	48.55*		0.31		0.99		0.66					
	l. peat	93.40*		0.47*		1.27		1.07					
B-23	0-1'	7.66		0.26		0.58	0.48	0.65		2.99			
	5'-7'	39.16*		0.45*		0.88	0.98	0.70				5.24*	
	silt	18.25		0.28		0.67	0.59	0.65					
	u. peat	110.87*		0.73*		2.18*	1.00	1.12*			2.35*		
	l. peat	26.46*		0.30		0.77							
B-24	0-1'	8.26		0.27		0.58	0.82	0.80				5.77*	
	1'-3'	7.29		0.24		0.68	0.68	0.63		2.95		4.40*	
	3'-5'	11.92		0.22		0.51	0.50	0.64					
	5'-7'	20.99				0.55							
	trans c-p	13.98		0.27		0.52		0.53					
	u. peat	83.99*		0.71*		1.85*	1.65*	1.71*			2.52*		
	l. peat	51.99*				1.15	0.89						

Table C-19
GSA Burn Pit
Core Bore Sample Analysis Results
(pCi/g)
(continued)

Core Number	Depth/ Type	K-40	Cs-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234	U-235
B-25	0-1'	8.74	0.23	0.35		0.96	0.71	0.76			0.85	5.71*	
	1'-3'	8.15	0.10	0.42	1.08*	1.21	0.89	1.06			1.37*	4.09*	
	3'-5'	8.78				0.62	0.67	0.52					
	5'-7'	14.77		0.41		0.95	0.89	0.97					
	silt trans	21.06		0.32		0.77	0.62	0.60					
	u. peat	30.28*				0.79							
	l. peat												
B-26	0-1'	10.78		0.20		0.89	0.96	1.08			0.92	4.42*	
	3'-5'	12.87		0.22		0.62	0.72	0.76					
	5'-7'	19.88		0.31		0.77	0.67	0.70					
	silt/peat	44.01*				1.08		0.76					
	u. peat												
	l. peat	41.89				0.94							
B-27	0-1'	6.84		0.29		0.59	0.74	0.76		5.87*		15.50*	
	1'-3'	7.61		0.22		0.58	0.69	0.69		4.74*	0.86	13.29*	
	3'-5'	7.75				0.51	0.51	0.64				1.86	
	5'-7'	9.80		0.28		0.60	0.76	0.74					
	7'-9'	8.55				0.52	0.71	0.55					
	silt	19.05				0.72	0.68	0.87					
	u. peat	57.50*											
	l. peat	45.22*				0.68							
B-28	0-1'	15.60		0.26		0.51	0.56	0.65				4.70*	
	1'-3'	12.35		0.27		0.47		0.47					
	3'-5'	63.32*		0.57*		1.28	1.35*	1.07			1.61*	4.08*	
	5'-7'	48.49*		0.75*		1.58*	1.26*	1.27*					
	silt	32.14*		0.37		0.83	0.72	0.89					
	u. peat	102.7*				1.56*	1.51*	1.53*					
	l. peat	60.77*		0.58*		1.38	1.26*	1.05					

Table C-19
GSA Burn Pit
Core Bore Sample Analysis Results
(pCi/g)
(continued)

Core Number	Depth/ Type	K-40	Co-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234	U-235
B-29	0-1'	5.95				0.56	0.73	0.76					
	3'-5'	15.00		0.30		0.57	0.64	0.71					
	silt	9.76		0.26		0.51	0.50	0.51			0.59		
	peat	28.08*				0.58							
B-30	0-1'	6.99		0.33		0.89	0.96	0.88		6.21*		11.36*	
	1'-3'	20.62				0.89		0.88				6.34*	
	3'-5'	34.47				0.86	0.92	0.77					
	5'-7'	12.90		0.28		0.54	0.72	0.73				2.61*	
	silt	29.88*		0.37		1.00	0.84	0.91					
	u. peat	37.22*				0.56							
	l. peat	190.4*		1.77*	3.38*	4.43*	3.41*	3.48*		13.59*	5.00*	4.71*	
B-31	0-1'	7.52		0.38		0.78	0.86	0.79			0.75		
	1'-3'	13.36				0.46	0.63	0.66					
	3'-5'	11.17		0.28		0.69	0.60	0.63					
	5'-7'	121.62*		1.02*		2.01*	2.12*	2.51*			3.78*		
	silt/trans	12.95		0.39		0.96	1.09*	1.08			1.06		
	peat	58.45*		1.12*		2.05*	1.92*	2.30*					

Blank cell indicates that the nuclide was not detected.

* Indicates results in excess of off-site mean + 3s.

Table C-20
GSA Soil Bore Samples
Comparision of Total Uranium
and Gamma Spectroscopy Analyses Data

			Total Uranium Analysis		Gamma Spectral Analysis	
Sample Number	Core Number	Depth/ Loc	Total Uranium (ug/g)	dU (pCi/g)	Th-234 (pCi/g)	dU (pCi/g)
287	21	0-1'	109.00	53.65	55.78	81.79
288	21	1'-3'	29.00	14.27	21.73	31.86
289	21	3'-5'	5.30	2.61	4.20	6.16
302	23	5'-7'	3.00	1.48	5.42	7.94
306	24	0-1'	9.10	4.48	5.77	8.45
307	24	1'-3'	6.90	3.40	4.40	6.44
313	25	0-1'	18.50	9.11	5.71	8.37
314	25	1'-3'	3.00	1.48	4.09	6.00
322	26	0-1'	6.80	3.35	4.42	6.49
328	27	0-1'	18.40	9.06	15.50	22.72
329	27	1'-3'	13.60	6.69	13.29	19.49
330	27	3'-5'	1.60	0.79	1.86	2.73
336	28	0-1'	3.90	1.92	4.70	6.90
338	28	3'-5'	0.90	0.44	4.08	5.98
347	30	0-1'	17.40	8.56	11.36	16.65
348	30	1'-3'	9.80	4.82	6.34	9.29
350	30	5'-7'	3.30	1.62	2.61	3.83
353	30	l. peat	8.20	4.04	4.71	6.91

*Note 1: Total Uranium Analysis dU = Total Uranium (ug/g) * 0.4922 (pCi/ug)*

Note 2: Gamma Spectral Analysis dU = Th-234 (pCi/g) / 0.682 (Th-234/dU)

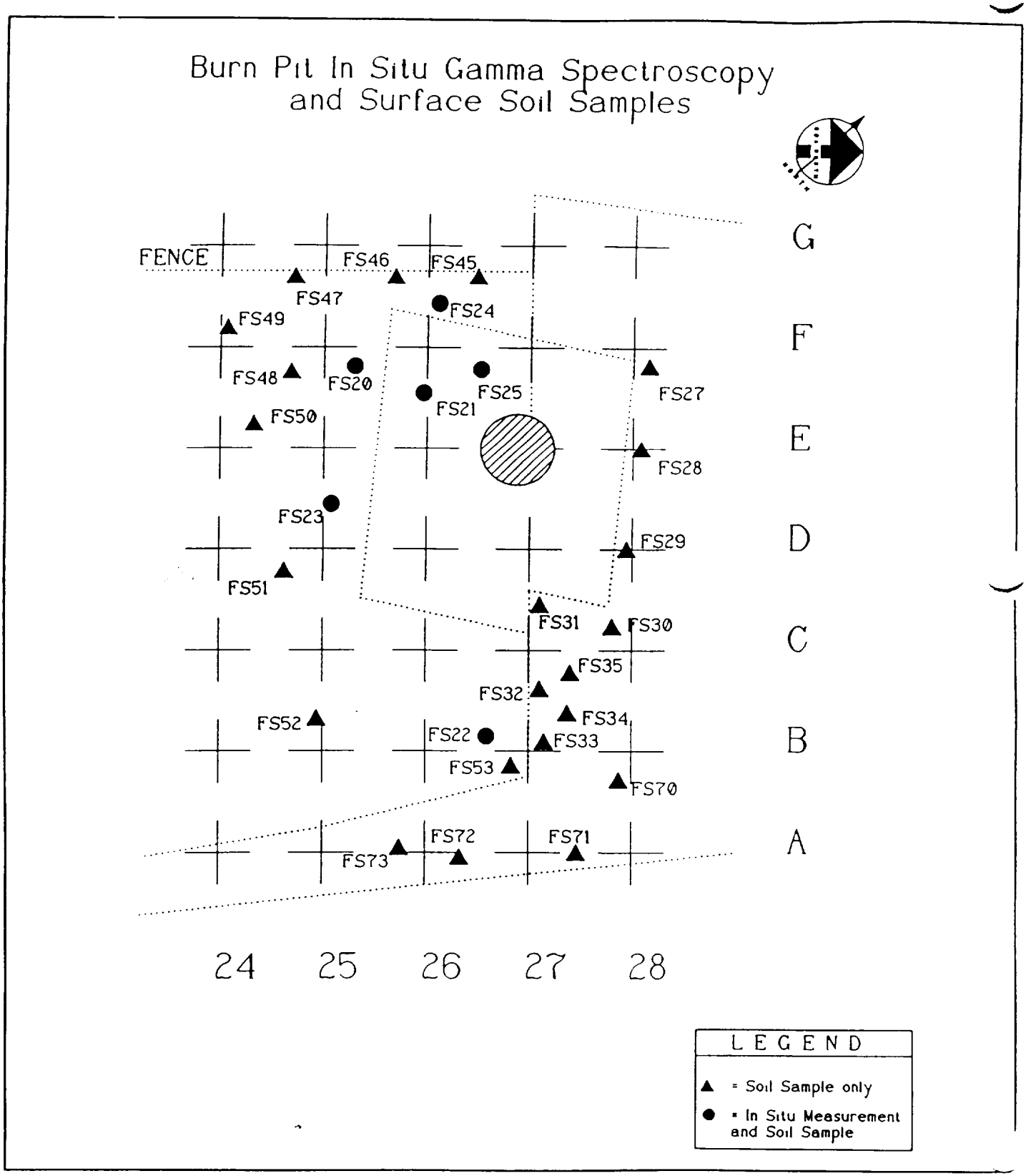


Figure C-29. Burn pit locations for in situ measurements and soil samples

Table C-21
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Analyses Results

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
						Massachusetts Grid					Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8	7.0	0.29	0.33	1.07		<3	6.68	0.21
GSA0687S	1690	Burn Pit		FS-21	1509	274.8	95.8	9	9.9	0.37	0.2	0.92		6.80	11.40	0.41
GSA0689S	1671	Burn Pit		FS-22	1503	192.6	226.2	7.8	13.4	0.27	1.08	0.93	54.3	8.47	24.90	0.51
GSA0691S	1636	Burn Pit		FS-23	1505	230.8	98.6	8.7	9.3	0.27	0.38	0.69		7.10	14.50	0.43
GSA0693S	1281	Burn Pit		FS-24	1537	325.9	77.2	7.9	10.8	0.21	0.92		120.12	<3	84.60	3.11
GSA0695S	1218	Burn Pit		FS-25	1515	311	120.4	7.8	11.18		0.29			5.70	12.10	0.35
GSA0764S	962.2	Burn Pit	Surface Soil	FS-27	1712	369.2	148.3	7.4	16.7	0.4	0.63	0.00		6.51	8.45	0.40
GSA0762S	896.3	Burn Pit	Surface Soil	FS-28	1713	335.6	177.8	7.7	13.4	0.3	0.51	0.00		0.00	5.46	0.00
GSA0760S	1097	Burn Pit	Surface Soil	FS-29	1714	302.8	213.7	7.9	15.5	0.3	0.40	1.11		3.31	4.60	0.21
GSA0758S	882	Burn Pit	Surface Soil	FS-30	1715	270.9	231.7	7.7	13.0		0.52	0.00		0.00	6.24	0.00
GSA0752S	1253	Burn Pit	Surface Soil	FS-31	1716	246.9	203.3	8.1	10.6		1.25	0.00	65.23	11.50	32.53	0.70
GSA0750S	1242	Burn Pit	Surface Soil	FS-32	1717	219.5	231.4	8	15.2		1.35	0.00		6.87	16.36	0.42
GSA0748S	997	Burn Pit	Surface Soil	FS-33	1718	204.5	248.8	8.1	18.6	0.3	1.55	0.00		0.00	10.08	0.00

Table C-21
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
											Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8	7.0	0.29	0.33	1.07		<3	6.68	0.21
GSA0754S	1007	Burn Pit	Surface Soil	FS-34	1719	223	244.8	8	13.1		0.52	0.00		0.00	0.00	0.00
GSA0756S	1289	Burn Pit	Surface Soil	FS-35	1720	232.7	233.7	8.1	13.2		0.44	0.00		4.62	8.03	0.28
GSA0736S	1098	GSA Area 20	Surface Soil	FS-36	1722	420.4	467.5	7.9	15.1		0.00	0.00		0.00	0.00	0.00
GSA0738S	1488	GSA Area 20	Surface Soil	FS-37	1723	409.8	434.3	9.9	13.5	0.3	0.00	0.00		0.00	0.00	0.00
GSA0746S	1155	GSA Area 20	Surface Soil	FS-38	1728	437	402.2	10.6	15.1		0.00	0.00		0.00	0.00	0.00
GSA0744S	1242	GSA Area 20	Surface Soil	FS-39	1727	466.1	370.7	10.8	12.1	0.3	0.00	0.00		0.00	0.00	0.00
GSA0742S	1601	GSA Area 20	Surface Soil	FS-40	1726	506.1	378.3	11	6.2	0.5	0.41	1.42		7.07	3.13	0.43
GSA0740S	1375	GSA Area 20	Surface Soil	FS-41	1725	532.9	365.8	11.3	7.6	0.4	0.55	1.35		6.67	5.11	0.41
GSA0734S	1174	GSA Area 20	Surface Soil	FS-42	1724	439.9	481.5	7.3	7.6	0.3	0.35	0.97		5.12	0.00	0.31
GSA0733S	1725	GSA Area 20	Surface Soil	FS-43	1730	472.2	513.4	8	14.2	0.2	0.16	0.74		0.00	0.00	0.00

Table C-21
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
											Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8	7.0	0.29	0.33	1.07		<3	6.68	0.21
GSA0731S	799.5	GSA Area 20	Surface Soil	FS-44	1729	507.5	505.7	4.7	6.3		1.09	0.00		0.00	0.00	0.00
GSA0774S	829.9	Burn Pit	Surface Soil	FS-45	1711	338	58.4	7.5	15.8	0.3	1.35	0.00		0.00	4.00	0.00
GSA0772S	584	Burn Pit	Surface Soil	FS-46	1710	313.6	37.1	7.7	11.7		4.50	0.00		0.00	11.26	0.00
GSA0770S	923	Burn Pit	Surface Soil	FS-47	1709	281.2	5.8	7.7	12.5	0.3	1.70	0.00		0.00	0.00	0.00
GSA0767S	1839	Burn Pit	Surface Soil	FS-48	1708	239.4	35.9	8.4	10.2	0.3	0.34	0.89		0.00	0.00	0.00
GSA0768S	1743	Burn Pit	Surface Soil	FS-49	1707	231.1	8.1	8.3	12.4	0.3	0.49	0.97		0.00	2.80	0.00
GSA0776S	1393	Burn Pit	Surface Soil	FS-50	1706	209.8	51.2	8.3	9.8	0.3	0.60	0.00		0.00	0.00	0.00
GSA0778S	1647	Burn Pit	Surface Soil	FS-51	1705	171.6	114.6	8.7	13.8		0.00	0.00		0.00	0.00	0.00
GSA0780S	1865	Burn Pit	Surface Soil	FS-52	1704	138.1	172.1	8.1	10.6	0.3	0.00	0.00		3.69	4.73	0.22
GSA0782S	1707	Burn Pit	Surface Soil	FS-53	1703	190.8	246.4	7.8	16.4	0.2	0.46	0.00		0.00	3.80	0.00

Table C-21
Burn Pit - Surface Soil Samples
Gamma Spectroscopy Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
											Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0685S	1734	Burn Pit		FS-20	1506	259.5	71.3	8	7.0	0.29	0.33	1.07		<3	6.68	0.21
GSA0816S	652	Area A25_A28	Surface Soil	FS-70					18.5		0.68	0		0	0	0
GSA0818S	1011	Area A25_A28	Surface Soil	FS-71					15.1	0.35	1.14	0		10.29	26.5	0.625
GSA0820S	1032	Area A25_A28	Surface Soil	FS-72					10.2		0.81	0		0	4.44	0
GSA0822S	890	Area A25_A28	Surface Soil	FS-73					13.7	0.26	1.03	0		8.31	16.03	0.504

Table C-22
Burn Pit
In Situ Gamma Spectroscopy Analyses Results
(pCi/g)

Location	K-40	Cs-137	Ac-228	Pb-214	Bi-214	Reported Ra-226	Pa-234m	Th-234	Reported U-235	Estimated U-235*	Estimated Ra-226*	Material	Sample Conc. (pCi/g)	Fraction of Limit
FS-20	9.13	0.14	1.00	1.06	1.29	0.00	0.00	4.12	0.20	0.08	2.0	U+d	10.3	1.03
FS-21	10.55	0.13	1.01	1.00	1.10	0.00	8.38	7.17	0.21	0.14	-2.3	DU	10.5	0.30
FS-22	13.41	0.36	0.84	0.94	0.94	0.00	7.60	9.27	0.25	0.18	-2.9	DU	13.6	0.39
FS-23	11.01	0.14	0.96	1.21	1.20	0.00	6.71	8.94	0.23	0.17	-2.8	DU	13.1	0.38
FS-24	12.40	0.25	0.63	0.53	0.63	0.00	24.14	12.74	0.25	0.24	0.1	DU	18.7	0.53
FS-25	9.01	0.12	0.64	0.60	0.62	0.00	5.41	8.39	0.13	0.16	-2.6	DU	12.3	0.35

*From alinsrst.wb1 - Ra-226 Critical Level Test

Note 1: This shows the in situ gamma spectroscopy results for the Burn Pit. It is a subset of GSINSALL.WB1. GSINSALL is a composite from INSFRAC2 and ALINSRST. Raw results come from INSFRAC2. The results for Estimated Ra-226 and Estimated U-235 come from ALINSRST. These results are derived through the Ra-226 Critical Level test (see technical basis in GSA report appendix).

Note 1 - The results for Measured Ra-226 (reported) are all zero. This is because the energy offset for each spectrum was adjusted so that the ~186 keV peak/s were all assigned to U-235. Estimates for Ra-226 and U-235 were then based on the Ra-226 CL test. As the spectroscopy system cannot properly distinguish between the Ra-226 and U-235 peak energies, and there are no confirming lines for either nuclide, this is the most satisfactory method for estimating these nuclides.

Table C-23
Burn Pit Soil Sample
Density and Moisture Content

Location	"In-earth" Density (g/cc)	Moisture Content %
FS20	2.3	12.0
FS21	2.2	26.8
FS22	1.7	9.0
FS23	2.0	11.3
FS24	1.8	29.5
FS25	1.5	12.7
Average	1.9	16.9
SMpl Var	0.1	78.3
Smpl SD	0.3	8.8
Max	2.3	29.5
Min	1.5	9.0

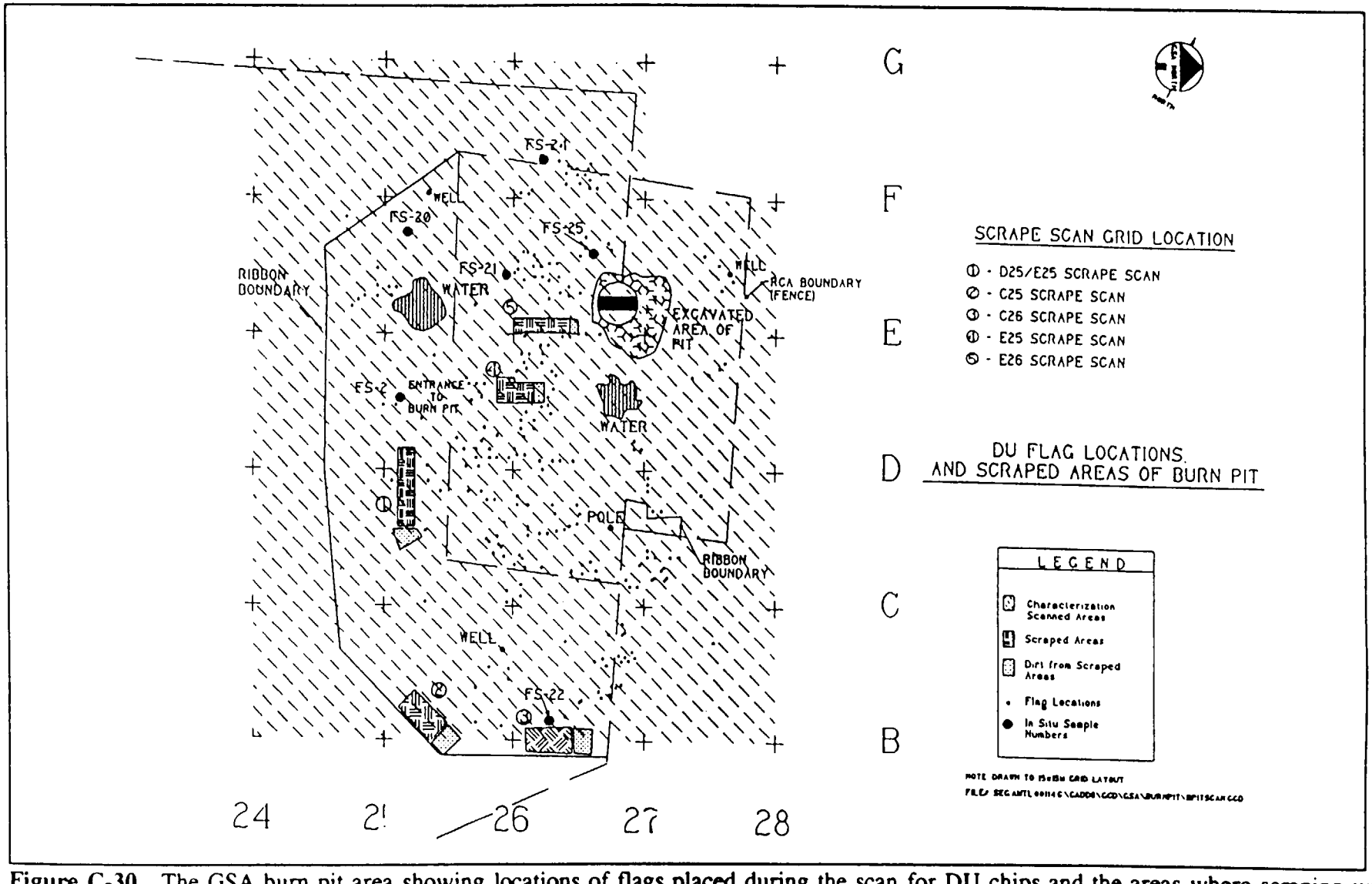


Figure C-30. The GSA burn pit area showing locations of flags placed during the scan for DU chips and the areas where scraping was done.

Table C-24
Burn Pit - Bulk Soil Samples
Gamma Spectroscopy Sample Analyses Results

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
						Massachusetts Grid					Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0706DD	1780	Burn Pit	No. #1	Lower Coarse	1508	279.5	93.3	8.8	15.5	0.98		2.95		<3	<2	<.2
GSA0708DD	1702	Burn Pit	No. #1	Lower Fines	1508	279.5	93.3	8.8	10.4	0.22				<2	<1	<.2
GSA0707DD	1901	Burn Pit	No. #1	Lower Middlings	1508	279.5	93.3	8.8	10.7	0.32		0.87		<2	<1	<.1
GSA0727S	2.5	Burn Pit	No. #1	Upper	1508	279.5	93.3	8.8	0.0	2287.1	0.00	0.00		0.00	2290.00	0.00
GSA0703DD	1685	Burn Pit	No. #1	Upper Coarse	1508	279.5	93.3	8.8	17.1	0.7		1.81		<3	<2	<.2
GSA0705DD	1481	Burn Pit	No. #1	Upper Fines	1508	279.5	93.3	8.8	9.9	0.4	0.28	1.07		4.57	8.23	0.28
GSA0704DD	1754	Burn Pit	No. #1	Upper Middlings	1508	279.5	93.3	8.8	12.9	0.3				<3	<2	<.2
GSA0712DD	1800	Burn Pit	No. #2	Lower Coarse	1507	266.5	66.4	7.9	13.7	1.0		2.75		6.02	<2	0.36
GSA0714DD	1738	Burn Pit	No. #2	Lower Fines	1507	266.5	66.4	7.9	8.0	0.3	0.29	0.85		5.06	6.69	0.31
GSA0713DD	1936	Burn Pit	No. #2	Lower Middlings	1507	266.5	66.4	7.9	9.3	0.3		0.77		2.10	2.40	0.13
GSA0709DD	1695	Burn Pit	No. #2	Upper Coarse	1507	266.5	66.4	7.9	14.5	1.02		2.47		3.86	<2	0.23

Table C-24
Burn Pit - Bulk Soil Samples
Gamma Spectroscopy Sample Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
						Massachusetts Grid					Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0706DD	1780	Burn Pit	No. #1	Lower Coarse	1508	279.5	93.3	8.8	15.5	0.98		2.95		<3	<2	<.2
GSA0711DD	1602	Burn Pit	No. #2	Upper Fines	1507	266.5	66.4	7.9	8.6	0.3	0.28	0.80		4.46	6.08	0.27
GSA0710DD	1914	Burn Pit	No. #2	Upper Middlings	1507	266.5	66.4	7.9	12.0	0.4		1.10		<2	2.77	<.2
GSA0718DD	1734	Burn Pit	No. #3	Lower Coarse	1504	191.9	230.9	7.4	14.3	0.8	0.00	2.14		4.07	0.00	0.25
GSA0720DD	1721	Burn Pit	No. #3	Lower Fines	1504	191.9	230.9	7.4	4.8	0.2	0.00	0.59		<2	<1	<.1
GSA0719DD	1400	Burn Pit	No. #3	Lower Middlings	1504	191.9	230.9	7.4	8.0	0.4	0.00	0.00		<3	<2	<.2
GSA0715S	1022	Burn Pit	No. #3	Upper Coarse	1504	191.9	230.9	7.4	20.4	0.4	0.00	1.86		<3	<2	<.2
GSA0717DD	1837	Burn Pit	No. #3	Upper Fines	1504	191.9	230.9	7.4	13.7	0.3	0.82	0.72	225.04	<3	121.00	2.38
GSA0716S	1690	Burn Pit	No. #3	Upper Middlings	1504	191.9	230.9	7.4	17.1	0.3	0.12	1.24		5.10	4.68	0.31

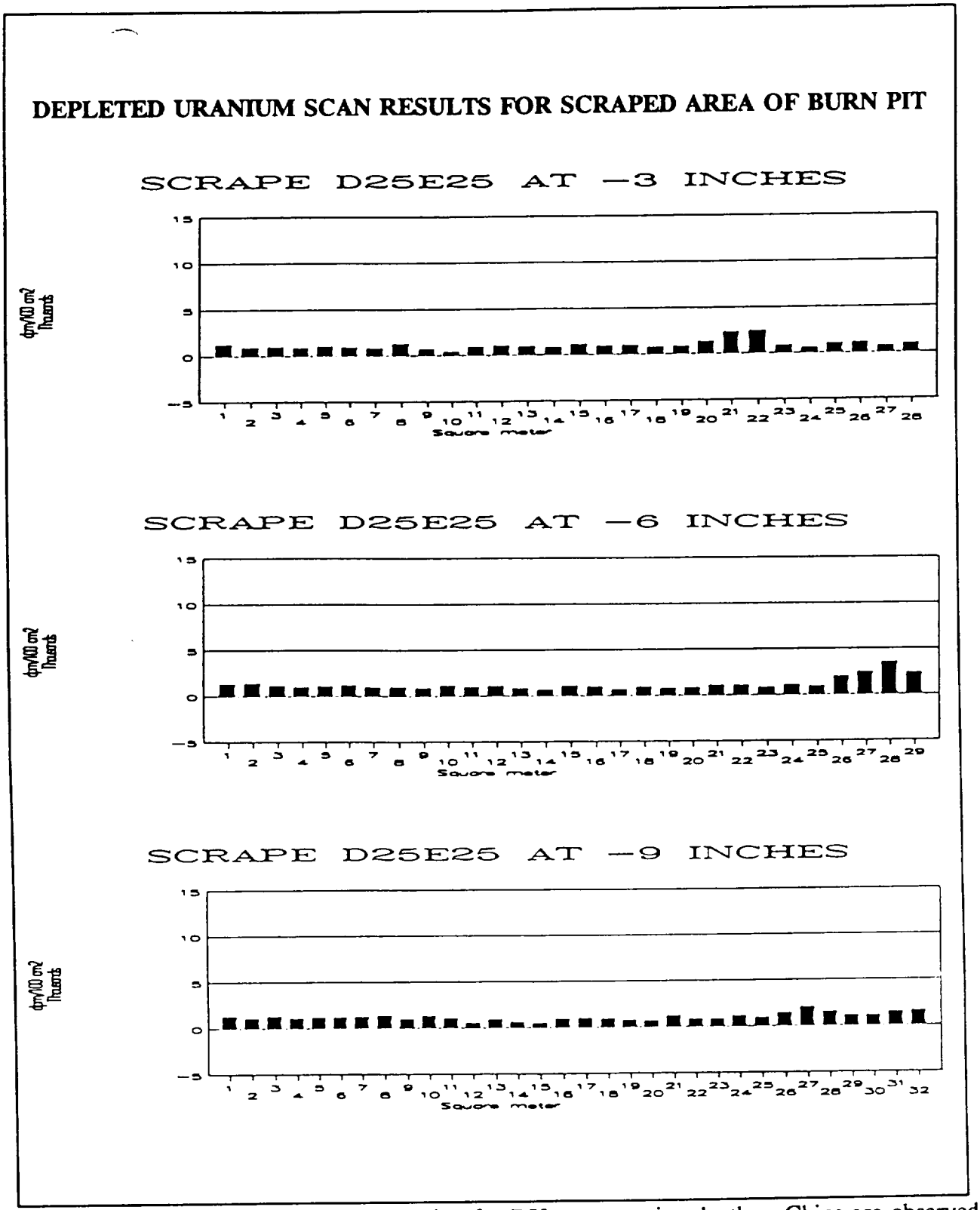


Figure C-31. Large area detector scanning for DU at successive depths. Chips are observed for readings over about
2000 dpm/100 cm^2.

DEPLETED URANIUM SCAN RESULTS FOR SCRAPED AREA OF BURN PIT

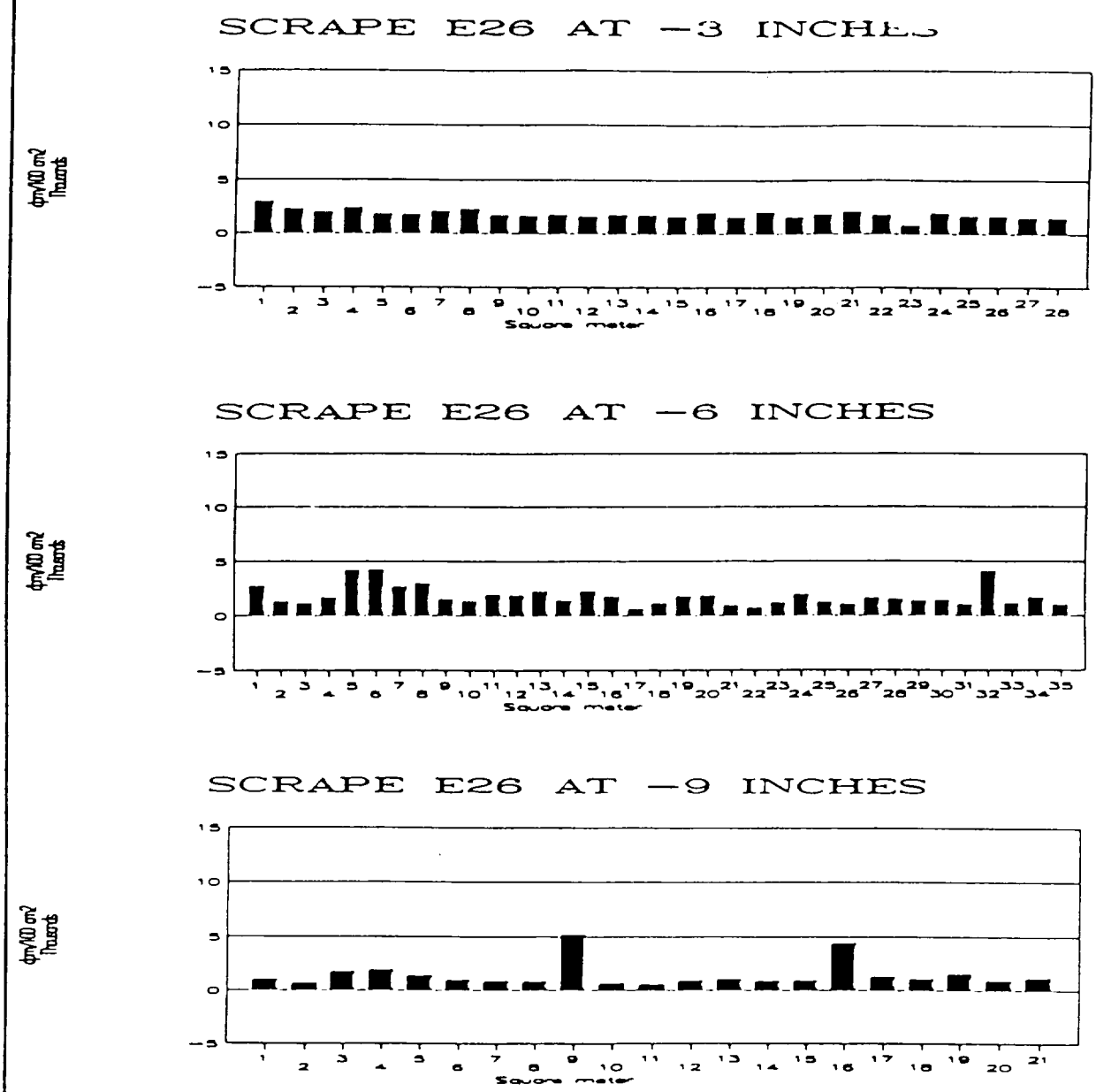
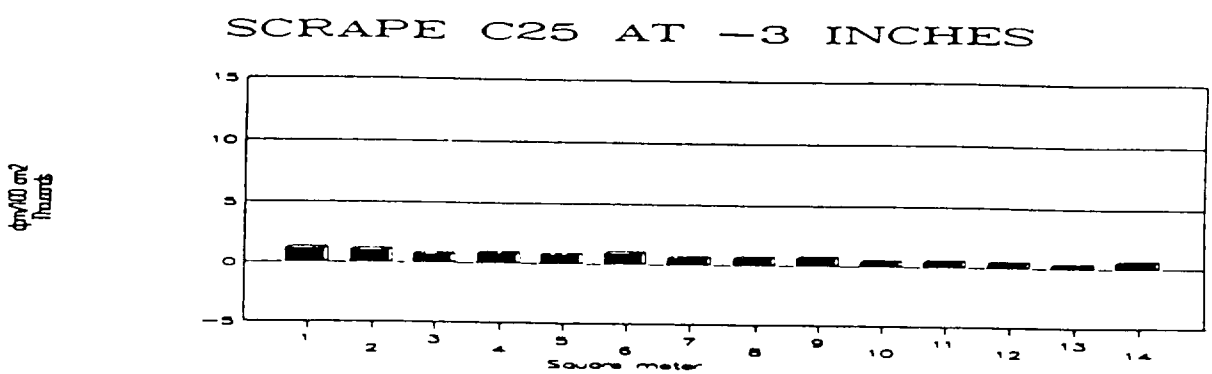


Figure C-32. At this location chips are observed at all depths.

DEPLETED URANIUM SCAN RESULTS FOR SCRAPED AREA OF BURN PIT



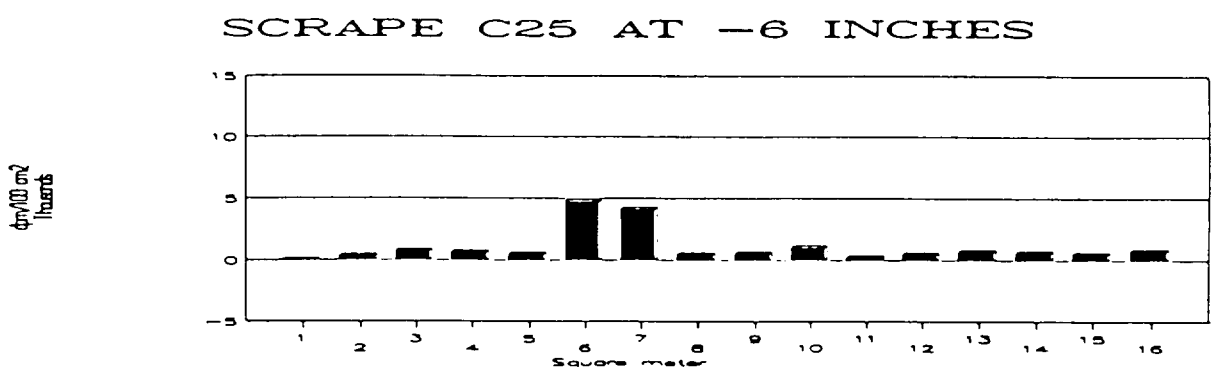


Figure C-33. No chips are seen at -3 inches, but -6 inches has chips in two square meters.

DEPLETED URANIUM SCAN RESULTS FOR SCRAPED AREA OF BURN PIT

Figure C-34. All data was lost for this location for -3 and -6 inches because of instrument failure

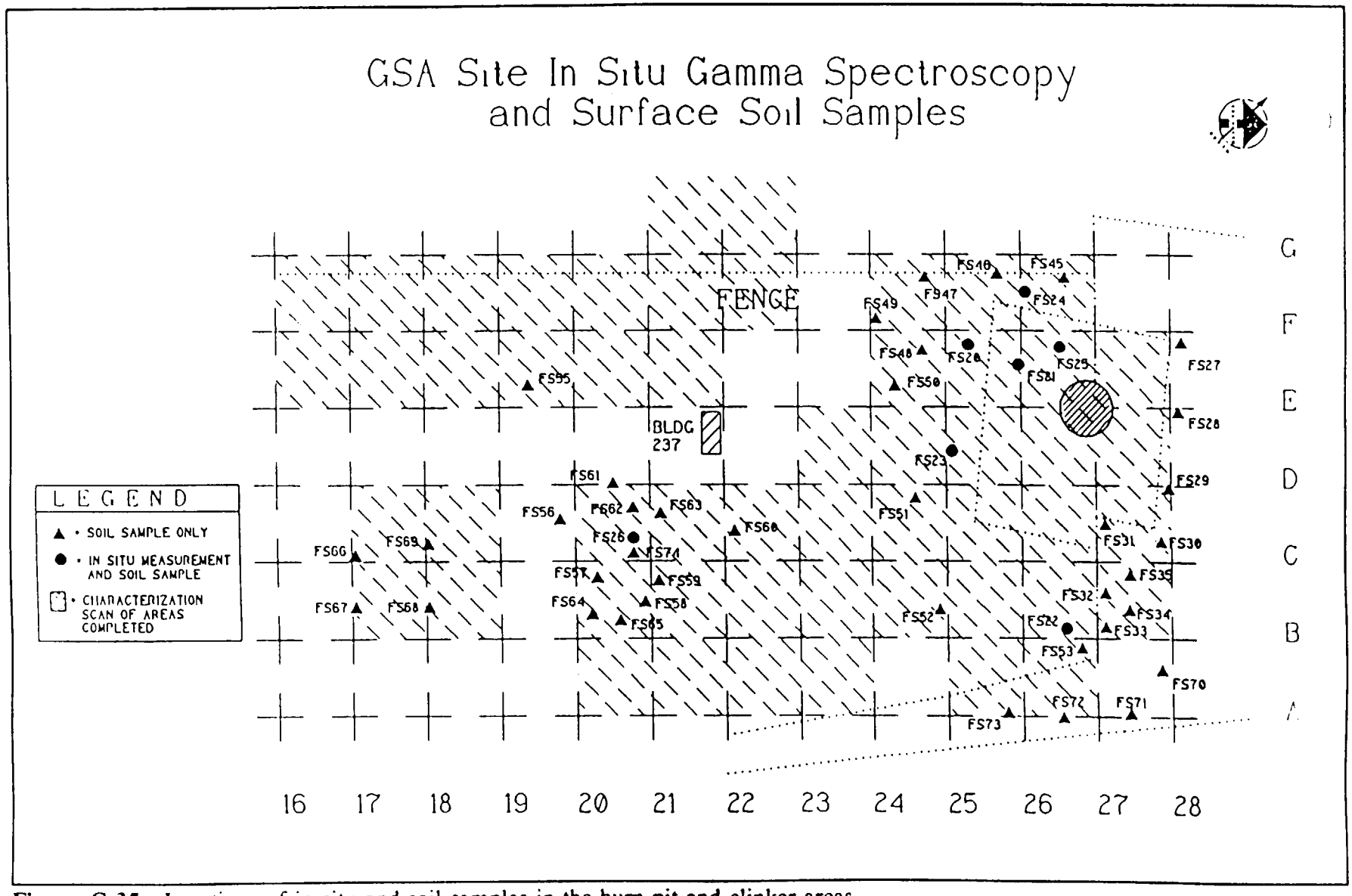


Figure C-35. Locations of in situ and soil samples in the burn pit and clinker areas

Table C-25
Clinker Area - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Concentration - pCi/g Cs-137	Ac-228	Pa-234m	Not Sand Corrected Ra-226	Th-234	U-235
GSA0697S	1077	Clinker Area	Surface Soil	FS-26					14.48	0.33	1.41		44.64	10.23	27.00	0.62
GSA0786S	1387	Clinker Area	Surface Soil	FS-55					12.2	0.5	0.44	1.38		5.75	0.00	0.35
GSA0788S	2027	Clinker Area	Surface Soil	FS-56					14.2	0.2	0.19	0.00		0.00	0.00	0.00
GSA0790S	1657	Clinker Area	Surface Soil	FS-57					9.9	0.2	0.29	0.00		5.60	9.77	0.34
GSA0792S	1535	Clinker Area	Surface Soil	FS-58					13.5		0.00	0.73		0.00	0.00	0.00
GSA0794S	1538	Clinker Area	Surface Soil	FS-59					12.0	0.3	0.00	0.00		0.00	0.00	0.00
GSA0796S	1378	Clinker Area	Surface Soil	FS-60					11.9	0.2	0.00	0.00		0.00	0.00	0.00
GSA0798S	1754	Clinker Area	Surface Soil	FS-61					14.0		0.30	0.00		0.00	0.00	0.00
GSA0800S	1225	Clinker Area	Surface Soil	FS-62					11.3	0.2	1.17	0.00	34.26	11.10	19.77	0.67
GSA0802S	1626	Clinker Area	Surface Soil	FS-63					12.4		0.47	0.00	32.36	0.00	20.14	0.80
GSA0804S	1730	Clinker Area	Surface Soil	FS-64					12.0	0.2	0.34	0.48	58.00	2.98	36.88	0.97

Table C-25
Clinker Area - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
						Massachusetts Grid					Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0697S	1077	Clinker Area	Surface Soil	FS-26					14.48	0.33	1.41		44.64	10.23	27.00	0.62
GSA0806S	1471	Clinker Area	Surface Soil	FS-65					11.3	0.2	0.57	0.70	45.30	15.95	25.79	0.97
GSA0808S	1612	Clinker Area	Surface Soil	FS-66					11.1	0.6	0.08	1.16		4.78	0.00	0.29
GSA0810S	1396	Clinker Area	Surface Soil	FS-67					13.3	0.5	0.00	1.85		0.00	0.00	0.00
GSA0812S	1396	Clinker Area	Surface Soil	FS-68					16.1	0.4	0.38	0.00		0.00	0.00	0.00
GSA0814S	1396	Clinker Area	Surface Soil	FS-69					14.3	0.3	0.00	0.57		0.00	0.00	0.00

Table C-26
Clinker Area
In Situ Gamma Spectroscopy Results

Location	K-40	Cs-137	Ac-228	Pb-214	BI-214	Reported Ra-226	Pa-234m	Th-234	Reported U-235	Estimated U-235*	Estimated Ra-226*	Material	Sample Conc. (pCi/g)	Fraction of Limit
FS-26	10.01	0.44	0.48	0.58	0.61	0.00	49.72	53.50	1.49	1.49	0.0	DU	78.7	2.25

*From alinsrst.wb1 - Ra-226 Critical Level Test

Note 1 - This shows the in situ gamma spec. results for the Clinker Area. It is a subset of GSINSALL.WB1. GSINSALL is a composite from INSFRAC2 and ALINSRST. Raw results come from INSFRAC2. The results for Estimated Ra-226 and Estimated U-235 come from ALINSRST. These results are derived through the Ra-226 Critical Level test (see technical basis in GSA report appendix).

Note 2 - The results for Measured Ra-226 (reported) are all zero. This is because the energy offset for each spectrum was adjusted so that the ~186 keV peak/s were all assigned to U-235. Estimates for Ra-226 and U-235 were then based on the Ra-226 CL test. As the spectroscopy system cannot properly distinguish between the Ra-226 and U-235 peak energies, and there are no confirming lines for either nuclide, this is the most satisfactory method for estimating these nuclides.

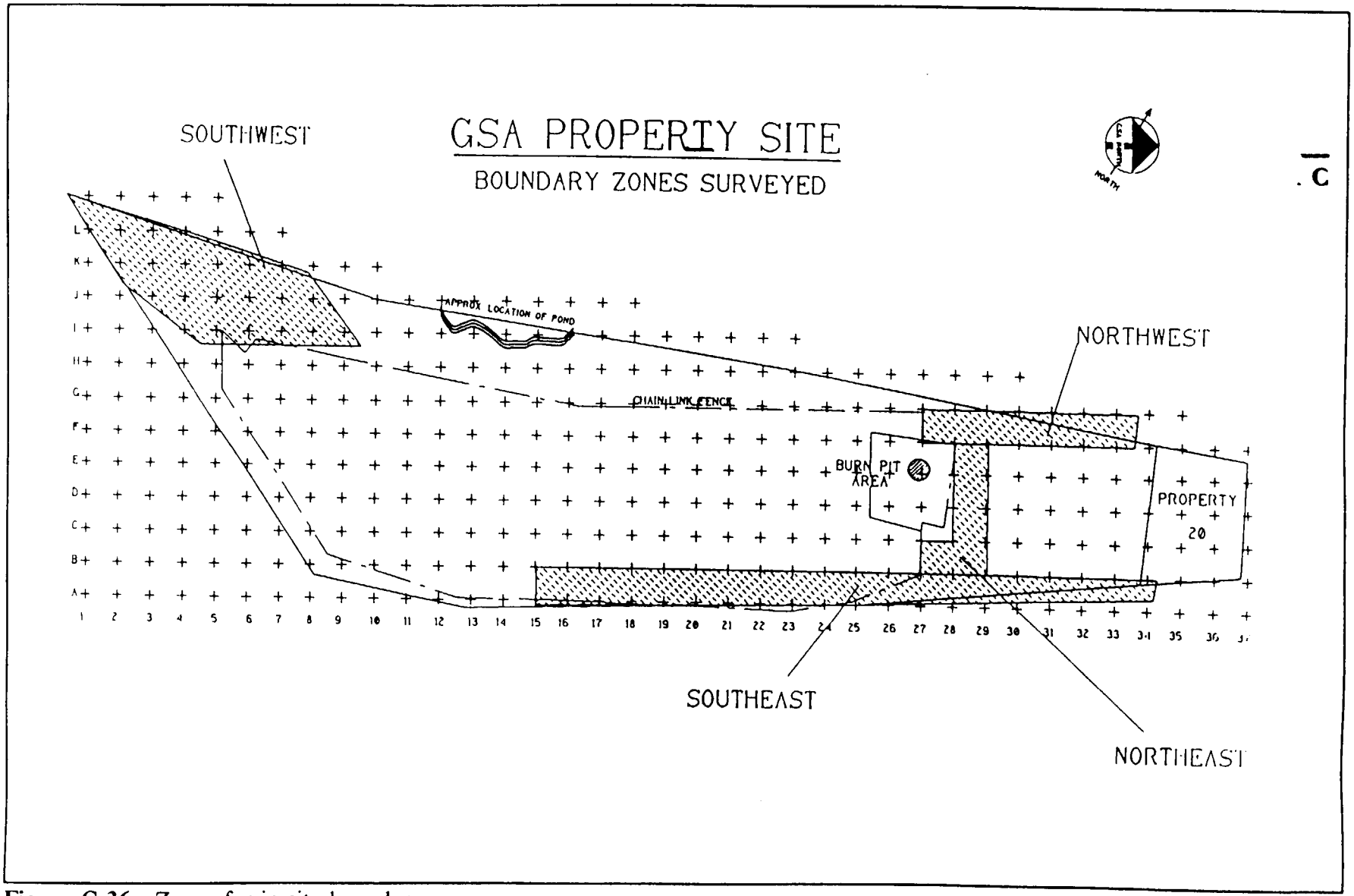


Figure C-36. Zones for in situ boundary survey

Table C-27
GSA Boundary
In Situ Gamma Spectroscopy Survey - Northeast
Concentration pCi/g

Sample, Location								
ID1	ID2	ID3	K-40	Cs-137	Ra-226	Pa-234m	Th-234	U-235
A	27		13.1	0.1	0.0	0.0	0.0	0.00
B	27	C1	9.2	0.2	0.9	0.0	1.7	0.00
C	27		10.9	0.3	3.2	10.3	10.5	0.00
C	27	C1	11.5	0.1	1.1	0.0	1.3	0.00
A	28		13.4	0.2	0.7	0.0	0.0	0.04
B	28		10.6	0.2	0.7	1.9	0.0	0.04
B	28	C1	9.7	0.1	0.0	-1.8	0.0	0.00
C	28		12.5	0.2	0.0	0.0	1.7	0.12
C	28	C1	11.7	0.1	2.1	0.0	0.0	0.13
D	28		10.4	0.2	2.0	0.0	4.1	0.00
D	28	C1	11.3	0.1	4.4	0.0	0.0	0.27
A	29		12.7	0.1	1.5	0.0	0.0	0.09
B	29		7.7	0.2	0.0	0.0	0.0	0.00
C	29		8.6	0.2	2.9	0.0	1.4	0.00

Table C-28
GSA Boundary
In Situ Gamma Spectroscopy Survey - Northwest
Concentration pCi/g

Sample, Location								
ID1	ID2	ID3	K-40	Cs-137	Ra-226	Pa-234m	Th-234	U-235
G	28		16.4	0.0	0.5	0.0	0.0	0.03
F	31		15.8	0.0	1.8	0.0	0.0	0.11
G	31	C1	16.0	0.1	0.0	0.0	0.0	0.00
F	32		14.9	0.0	1.8	0.0	0.0	0.11
F	32	C1	16.3	0.1	1.3	0.0	0.0	0.08
F	32	C2	15.9	0.1	0.0	0.0	1.1	0.00
F	33	C1	17.3	0.1	2.1	0.0	0.0	0.13

Table C-29
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southeast
Concentration pCi/g

Sample, Location								
ID1	ID2	ID3	K-40	Cs-137	Ra-226	Pa-234m	Th-234	U-235
B	15		12.8	0.4	0.0	0.0	1.4	0.00
B	15	C1	12.7	0.4	2.6	0.6	0.0	0.16
A	16		11.2	0.6	0.0	0.0	0.0	0.00
B	16		12.6	0.4	2.4	0.0	1.0	0.00
B	16	C1	10.9	0.4	0.0	0.0	0.1	0.09
A	17		8.9	0.4	0.0	0.0	0.0	0.00
B	17		11.9	0.5	3.2	0.0	0.5	0.00
B	17	C1	13.5	0.4	0.0	0.0	0.2	0.12
A	18		8.7	0.6	2.1	0.0	0.0	0.13
B	18		11.3	0.6	1.2	0.0	0.0	0.07
B	18	C1	12.1	0.4	2.2	0.0	0.0	0.13
A	19		8.9	0.4	0.6	0.0	0.0	0.04
B	19		12.6	0.3	0.8	0.0	0.0	0.05
B	19	C1	11.7	0.4	2.0	0.0	3.0	0.12
A	20		9.0	0.3	2.1	0.0	0.0	0.13
B	20		10.6	0.3	1.9	0.0	1.3	0.00
B	20	C1	9.7	0.4	0.0	0.0	2.8	0.00
A	21		5.8	0.2	0.0	0.0	0.0	0.00
B	21		9.8	0.3	0.0	0.0	0.0	0.00
B	21	C1	7.7	0.3	1.4	0.0	0.0	0.09
A	22		5.3	0.3	0.6	0.0	-0.2	0.04
B	22		7.4	0.2	1.3	0.0	0.0	0.08
B	22	C1	6.0	0.2	0.0	0.0	0.0	0.00
A	23		6.9	0.3	0.0	0.0	0.0	0.00
B	23		9.6	0.3	0.9	0.0	0.0	0.06
B	23	C1	8.3	0.2	0.0	0.0	0.0	0.00
A	24		8.6	0.2	1.3	1.6	0.0	0.08
B	24		10.3	0.3	1.9	0.0	0.0	0.12
B	24	C1	8.6	0.3	1.3	0.0	0.0	0.08
A	25		11.7	0.3	1.9	0.0	2.4	0.11
B	25		12.2	0.1	0.4	0.0	0.0	0.03

Table C-29
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southeast
Concentration pCi/g
(continued)

Sample, Location								
ID1	ID2	ID3	K-40	Cs-137	Ra-226	Pa-234m	Th-234	U-235
B	25	C1	11.1	0.3	2.0	0.0	2.6	0.00
A	26		10.9	0.3	0.1	0.0	0.0	0.00
B	26		11.4	0.3	4.1	0.0	3.4	0.00
B	26	C1	6.2	0.3	1.4	0.0	0.0	0.08
A	27		13.1	0.1	0.0	0.0	0.0	0.00
B	27		10.2	0.4	2.5	0.0	3.6	0.00
B	27	C1	9.2	0.2	0.9	0.0	1.7	0.00
A	28		13.4	0.2	0.7	0.0	0.0	0.04
B	28		10.6	0.2	0.7	1.9	0.0	0.04
B	28	C1	9.7	0.1	0.0	-1.8	0.0	0.00
A	29		12.7	0.1	1.5	0.0	0.0	0.09
B	29		7.7	0.2	0.0	0.0	0.0	0.00
B	29	C1	10.7	0.1	0.0	0.0	0.0	0.00
B	30		11.9	0.2	0.0	0.0	0.0	0.00
B	30	C1	12.1	0.2	0.0	0.0	0.0	0.00
B	31		10.4	0.1	3.6	0.0	2.0	0.00
B	31	C1	12.5	0.2	0.0	0.0	0.0	0.00
B	32		10.4	0.2	0.0	0.0	0.0	0.00
B	32	C1	9.3	0.1	1.8	0.0	0.0	0.11
B	33		9.4	0.2	0.0	0.0	0.0	0.00
B	33	C1	7.3	0.1	2.6	0.0	3.0	0.16
C	33	C1	5.1	0.0	0.0	0.0	2.9	0.30
B	34		10.3	0.2	1.3	0.0	0.0	0.08
B	34	C1	7.2	0.2	0.0	0.0	0.0	0.00

Table C-30
GSA Boundary
In Situ Gamma Spectroscopy Survey - Southwest
Concentration pCi/g

Sample, Location								
ID1	ID2	ID3	K-40	Cs-137	Ra-226	Pa-234m	Th-234	U-235
H	10		17.4	0.1	1.7	0.0	0.0	0.10
H	11		12.0	0.3	1.5	0.0	0.0	0.09
H	11	R	9.5	0.2	1.0	0.0	0.0	0.06
I	5		13.8	0.1	0.0	0.0	0.0	0.00
I	6		14.3	0.0	0.0	0.0	0.0	0.00
I	7		11.0	0.1	1.3	0.0	0.0	0.08
I	7	C1	11.7	0.3	0.0	0.0	0.0	0.00
I	8		10.2	0.1	0.0	0.0	0.0	0.00
I	8	C1	10.8	0.2	1.8	0.0	0.0	0.11
I	9		8.3	0.2	1.4	0.0	0.0	0.09
I	9	C1	10.7	0.2	2.5	0.0	0.0	0.15
J	3		13.0	0.1	0.0	0.0	0.0	0.00
J	3	C1	11.9	0.1	0.0	0.0	0.0	0.00
J	4		11.9	0.1	0.0	0.0	0.0	0.00
J	4	C1	12.5	0.2	0.0	0.0	0.0	0.00
J	5		11.0	0.2	2.0	0.0	0.0	0.12
J	6		11.4	0.1	1.7	0.0	0.0	0.10
J	6	C1	9.7	0.2	0.0	0.0	0.0	0.00
J	7	C1	9.6	0.2	0.0	0.0	0.0	0.00
K	3		13.7	0.1	0.0	0.0	0.0	0.00
K	3	C1	14.3	0.0	0.0	0.0	0.0	0.00
K	4		13.4	0.0	0.6	0.0	0.0	0.03
L	2		14.4	0.1	0.0	0.0	0.0	0.00
L	2	C1	16.9	0.1	3.9	0.0	0.0	0.24

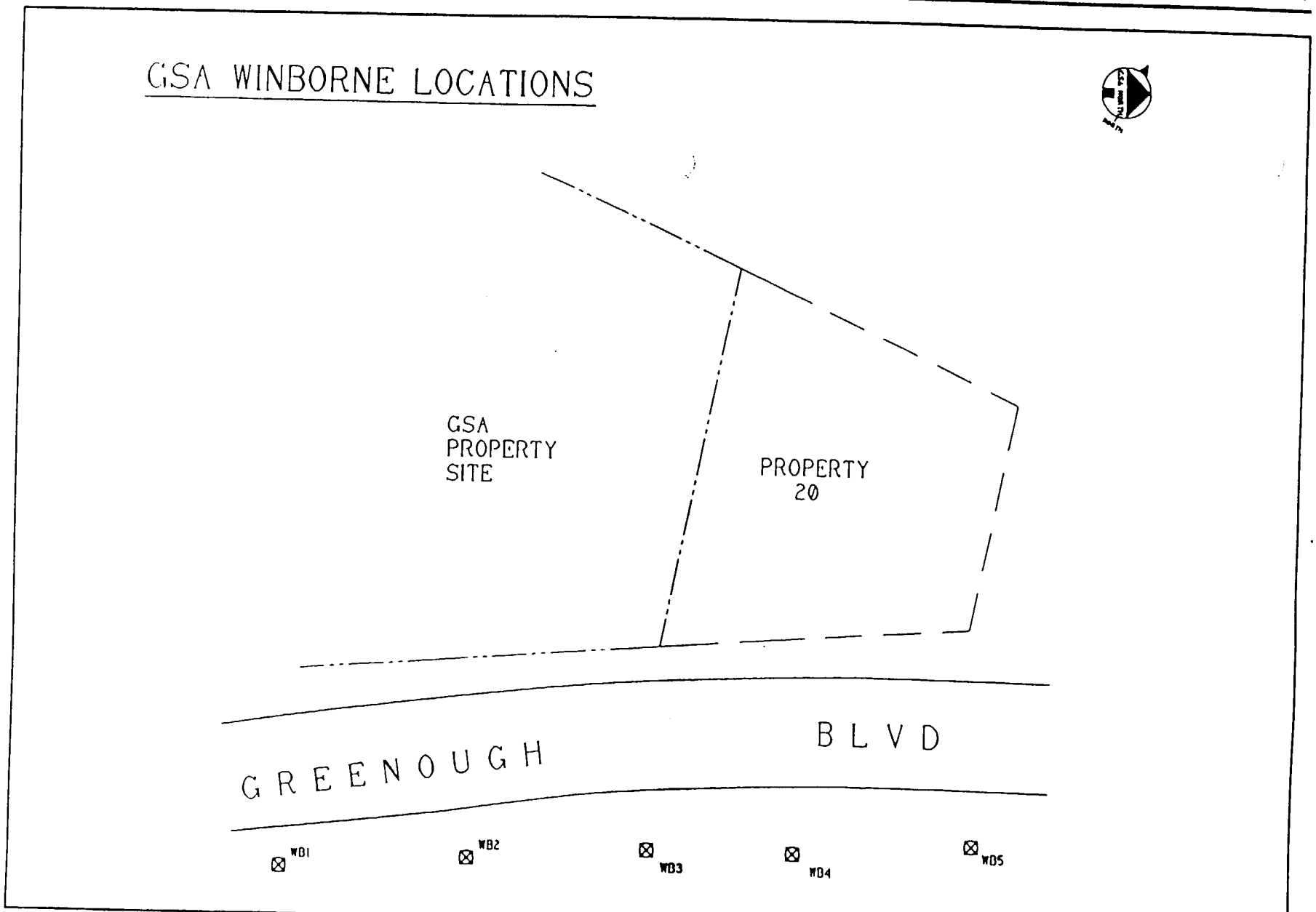


Figure C-37. Location selected for sampling for windborne deposition of depleted uranium

Table C-31
Windborne - Surface and SubSurface Soil Samples
Gamma Spectroscopy Sample Analyses Results

File No.	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Concentration - pCi/g			Not Sand Corrected		U-235
											Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	
GSA0584S	834	East of Greenough	Windborne 1	No. 1	1540	110.8	396.7	11.8	15.1	0.23	0.77	0.98		<2	<1	<.1
GSA0601S	1178	East of Greenough	Windborne 2	No. 1	1539	195.4	643.5	11.5	8.3		0.28			<3	<2	<.2
GSA0603S	1060	East of Greenough	Windborne 2	No. 2	1539	195.4	643.5	11.5	7.1	0.2	0.29			<3	<2	<.2
GSA0604S	982	East of Greenough	Windborne 3	No. 1	1565	291.7	541.2	10.8	15.4	0.27				<3	<2	<.2
GSA0599S	949	East of Greenough	Windborne 3	No. 2	1565	291.7	541.2	10.8	15.5	0.34				<3	<2	<.2
GSA0559S	1181	East of Greenough	Windborne 4	No. 1	1564	372.4	606.4	11	11.8	0.23				<3	<2	<.2
GSA0607S	967.8	East of Greenough	Windborne 4	No. 2	1564	372.4	606.4	11	16	0.34				<3	<2	<.2
GSA0605S	797	East of Greenough	Windborne 5	No. 1	1563	439.2	663.9	5.4	14.2			1.04		<3	<2	<.2
GSA0606S	673.7	East of Greenough	Windborne 5	No. 2	1563	439.2	663.9	5.4	9.8	2.36				<2	<1	<.1

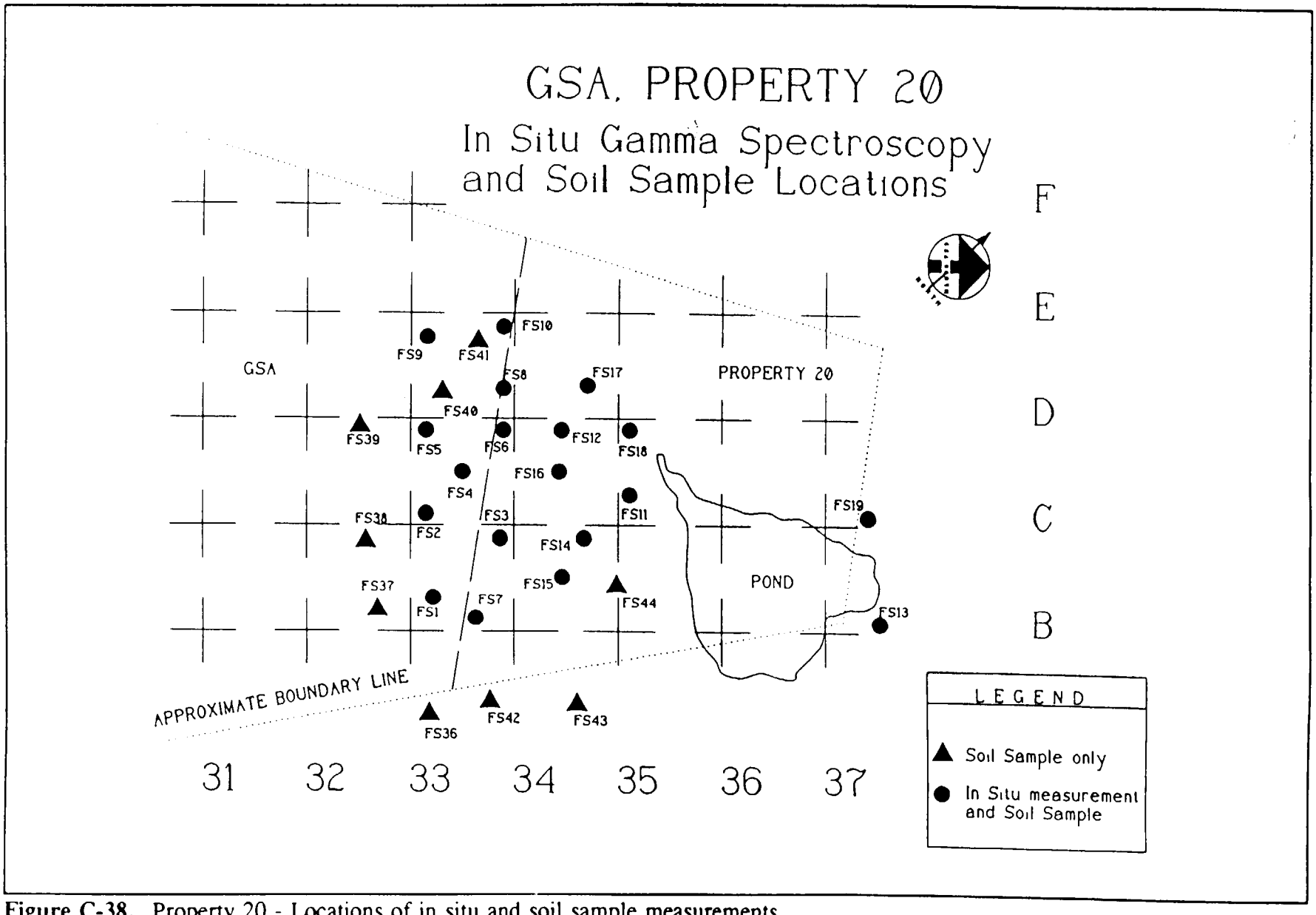


Figure C-38. Property 20 - Locations of in situ and soil sample measurements

Table C-32
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet			Concentration - pCi/g			Not Sand Corrected		
						Massachusetts Grid			K-40	Tl-208	Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	U-235
GSA0616S	1541	GSA Area 20	Surface Soil	FS-01	1547	438.4	445.5	10.1		0.63		1.66		19.70	13.00	1.20
GSA0618S	1335	GSA Area 20	Surface Soil	FS-02	1542	463.1	418	11.1	7.5	0.35		1	31.43	9.50	16.30	0.58
GSA0620S	1446	GSA Area 20	Surface Soil	FS-03	1545	484.2	444.3	10	3.93	0.29	0.2			8.10	7.70	0.49
GSA0624S	1632	GSA Area 20	Surface Soil	FS-04	1543	482.9	419.1	10.8	2	0.78		2.39	42.24	10.30	18.20	0.63
GSA0622S	1415	GSA Area 20	Surface Soil	FS-05	1548	486.4	393.5	10.7	3.14	0.52		1.51	191.13	0.00	98.50	2.39
GSA0626S	1337	GSA Area 20	Surface Soil	FS-06	1550	506.2	417.9	10.4	8.94	0.37		0.9		5.00	4.90	0.30
GSA0664S	1459	GSA Area 20	Surface Soil	FS-07	1546	451.4	459.7	9.5		0.74		1.6		21.80	9.79	1.32
GSA0628S	1249	GSA Area 20	Surface Soil	FS-08	1549	531	394.7	9.8	9.07	0.33	0.22	1.03		5.69	7.50	0.35
GSA0630S	1040	GSA Area 20	Surface Soil	FS-09	1551	522.2	351.7	11.2	12.17	0.24	0.21			0.00	0.00	0.00
GSA0632S	1371	GSA Area 20	Surface Soil	FS-10	1552	556.8	371.3	10.2	15.0	0.32				<3	<2	<.2
GSA0666S	1367	GSA Area 20	Surface Soil	FS-11	1557	543.4	473.4	8.3	14.9	0.22	0.13	0.96		<3	<2	<.2

Table C-32
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing (Massachusetts Grid)	695000 + Easting (Massachusetts Grid)	Elevation Feet	K-40	Tl-208	Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	U-235
									Concentration - pCi/g					Not Sand Corrected		
GSA0682S	1434	GSA Area 20	Surface Soil	FS-13	1562	583.8	593.3	6.8	11.9	0.73	0.34	1.68		<3	<2	<.2
GSA0670S	1228	GSA Area 20	Surface Soil	FS-14	1558	510	473.1	9	13.9	0.36				<3	<2	<.2
GSA0672S	1324	GSA Area 20	Surface Soil	FS-15	1559	490.9	496.5	8.6	9.8	0.34	0.1	1.52		8.18	3.90	0.50
GSA0674S	1313	GSA Area 20	Surface Soil	FS-16	1556	529.5	450.4	9.4	16.0	0.23	0.342	0		<3	<2	<.2
GSA0676S	1358	GSA Area 20	Surface Soil	FS-17	1554	565.9	424.8	9.6	13.7	0.29	0.16			<2	<2	<.2
GSA0678S	1172	GSA Area 20	Surface Soil	FS-18	1555	563.5	450.4	7.3	11.5		0.16			<3	<2	<.2
GSA0680S	1043	GSA Area 20	Surface Soil	FS-19	1561	614.5	546.5	7.2	16.8	0.3				<3	<2	<.2
GSA0736S	1098	GSA Area 20	Surface Soil	FS-36	1722	420.4	467.5	7.9	15.1		0.00	0.00		0.00	0.00	0.00
GSA0738S	1488	GSA Area 20	Surface Soil	FS-37	1723	409.8	434.3	9.9	13.5	0.3	0.00	0.00		0.00	0.00	0.00
GSA0746S	1155	GSA Area 20	Surface Soil	FS-38	1728	437	402.2	10.6	15.1		0.00	0.00		0.00	0.00	0.00
GSA0744S	1242	GSA Area 20	Surface Soil	FS-39	1727	466.1	370.7	10.8	12.1	0.3	0.00	0.00		0.00	0.00	0.00

Table C-32
Property 20 - Surface Soil Samples
Gamma Spectroscopy Sample Analyses Results
(Continued)

File Number	Mass grams	Sample ID 1	Sample ID 2	Sample ID 3	Land Survey Point	497000 + Northing	695000 + Easting	Elevation Feet			Concentration - pCi/g			Not Sand Corrected		
						Massachusetts Grid			K-40	Tl-208	Cs-137	Ac-228	Pa-234m	Ra-226	Th-234	U-235
GSA0742S	1601	GSA Area 20	Surface Soil	FS-40	1726	506.1	378.3	11	6.2	0.5	0.41	1.42		7.07	3.13	0.43
GSA0740S	1375	GSA Area 20	Surface Soil	FS-41	1725	532.9	365.8	11.3	7.6	0.4	0.55	1.35		6.67	5.11	0.41
GSA0734S	1174	GSA Area 20	Surface Soil	FS-42	1724	439.9	481.5	7.3	7.6	0.3	0.35	0.97		5.12	0.00	0.31
GSA0733S	1725	GSA Area 20	Surface Soil	FS-43	1730	472.2	513.4	8	14.2	0.2	0.16	0.74		0.00	0.00	0.00
GSA0731S	799.5	GSA Area 20	Surface Soil	FS-44	1729	507.5	505.7	4.7	6.3		1.09	0.00		0.00	0.00	0.00

Table C-33
Property 20
In Situ Gamma Spectroscopy Sample Analyses Results

Location	K-40	Cs-137	Ac-228	Pb-214	Bi-214	Reported Ra-226	Pa-234m	Th-234	Reported U-235	Estimated U-235*	Estimated Ra-226*	Material	Sample Conc. (pCi/g)	Fraction of Limit
FS-01	5.34	0.15	1.03	2.77	3.20	0.00	16.05	4.27	0.47	0.08	6.4	U+d	15.0	1.50
FS-02	6.34	0.10	0.79	1.55	1.77	0.00	15.38	7.20	0.35	0.14	-2.3	DU	10.6	0.30
FS-03	7.89	0.18	0.88	1.92	2.03	0.00	0.00	3.50	0.26	0.07	3.2	U+d	10.3	1.03
FS-04	5.85	0.11	1.21	2.09	2.39	0.00	7.44	9.82	0.38	0.19	3.2	U+d	23.0	2.30
FS-05	6.07	0.19	0.78	1.58	1.78	0.00	13.75	6.16	0.24	0.12	1.9	U+d	14.4	1.44
FS-06	9.18	0.13	0.86	1.49	1.56	0.00	1.74	2.27	0.00	0.04	-0.7	DU	3.3	0.10
FS-07	4.93	0.14	0.93	2.61	3.17	0.00	0.00	3.11	0.26	0.06	-1.0	DU	4.6	0.13
FS-08	9.28	0.17	0.67	1.01	1.33	0.00	0.00	0.00	0.16	0.00	0.0	DU	0.0	0.00
FS-09	10.32	0.22	1.08	0.79	1.03	0.00	0.00	0.00	0.16	0.00	0.0	DU	0.0	0.00
FS-10	14.22	0.08	0.61	0.55	0.63	0.00	0.00	0.00	0.00	0.00	0.0	DU	0.0	0.00
FS-11	12.11	0.12	0.54	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.0	DU	0.0	0.00
FS-12	10.31	0.16	0.66	0.59	0.55	0.00	0.00	0.00	0.08	0.00	1.3	U+d	1.3	0.13
FS-13	12.12	0.12	0.49	0.48	0.52	0.00	0.00	0.00	0.00	0.00	0.0	DU	0.0	0.00
FS-14	11.37	0.19	0.64	0.58	0.67	0.00	0.00	0.00	0.09	0.00	1.4	U+d	1.4	0.14
FS-15	11.19	0.13	0.70	0.64	0.74	0.00	0.00	0.00	0.09	0.00	1.5	U+d	1.5	0.15
FS-16	12.52	0.17	0.63	0.55	0.60	0.00	0.00	0.00	0.07	0.00	1.1	U+d	1.1	0.11
FS-17	13.44	0.12	0.73	0.56	0.63	0.00	0.00	0.00	0.00	0.03	-0.6	DU	2.7	0.08
FS-18	11.47	0.18	0.65	0.62	0.78	0.00	0.00	0.00	0.06	0.00	0.9	DU	0.0	0.00
FS-19	12.69	0.16	0.59	0.47	0.52	0.00	0.00	0.00	0.00	0.00	0.0	DU	0.0	0.00

Table C-33
Property 20
In Situ Gamma Spectroscopy Sample Analyses Results
(Continued)

*From alinsrst.wb1 - Ra-226 Critical Level Test

Note 1 - This shows the in situ gamma spec. results for the Property 20 measurements. It is a subset of GSINSALL.WB1. GSINSALL is a composite from INSFRAC2 and ALINSRST. Raw results come from INSFRAC2. The results for Estimated Ra-226 and Estimated U-235 come from ALINSRST. These results are derived through the Ra-226 Critical Level test (see technical basis in GSA report appendix).

Note 2 - The results for Measured Ra-226 (reported) are all zero. This is because the energy offset for each spectrum was adjusted so that the ~186 keV peak/s were all assigned to U-235. Estimates for Ra-226 and U-235 were then based on the Ra-226 CL test. As the spectroscopy system cannot properly distinguish between the Ra-226 and U-235 peak energies, and there are no confirming lines for either nuclide, this is the most satisfactory method for estimating these nuclides.

Table C-34
Property 20 Soil Sample
Density and Moisture Content

Location	"In-earth" Density (g/cc)	Moisture Content %
FS1	1.4	4.5
FS2	1.5	10.4
FS3	1.5	9.2
FS4	1.9	6.4
FS5	1.6	9.2
FS6	1.5	10.1
FS7	1.5	14.6
FS8	1.4	7.9
FS9	1.4	16.9
FS10	1.6	8.2
FS11	1.0	8.8
FS12	1.6	29.7
FS13	1.3	-0.1
FS14	1.4	-1.0
FS15	1.2	0.8
FS16	1.5	6.7
FS17	1.8	9.3
FS18	1.6	16.8
FS19	1.1	10.7
Average	1.5	9.4
Smpl. Var	0.0	48.4
Smpl SD	0.2	7.0
Max	1.9	29.7
Min	1.0	-1.0

Table C-35
GSA Soil from Woods North of Perimeter Fence
Gamma Spectrum Analyses (pCi/g)

Sample Number	Location	K-40	Cs-137	Tl-208	Bi-212	Pb-212	Bi-214	Pb-214	Ra-224	Ra-226	Ac-228	Th-234
GSA271S	1@surf			0.69		2.46	9.03	9.15		18.06	1.84	5.22
GSA272S	1@18"			0.59	1.13	2.27	8.42	8.25		18.87	1.66	5.70
GSA276S	1@3'			0.26		1.04	2.64	2.68		6.14		
GSA273S	2@surf			0.32		1.54	6.56	6.87		13.34	1.35	
GSA274S	2@18"			0.46		1.83	5.52	5.90	10.65		1.08	6.26
GSA275S	2@3'	2.76		0.50	0.66	1.60	5.53	5.01			1.17	6.90

APPENDIX F

TERMINATION SURVEY METHODS

APPENDIX F
TERMINATION SURVEY METHODS

Final (termination) surveys were performed in Building 237, in the annex of Building 235, in Building 653 (Pumphouse), and in several manholes, to determine acceptability for unrestricted use. This task required the performance of surveys on building surfaces for removable and fixed contamination, and gamma exposure rate measurements at one meter from the building surface. Sludge samples were taken from the manholes. The final survey was performed using procedures established for the MTL facilities decommissioning in *AMTL Termination Surveys Work Plan for Decommissioning, Demolition and Site Restoration of the Research Reactor and Decommissioning of the Radiation Facilities at the U.S. Army Materials Technology Laboratory, Watertown, Massachusetts.*

1. BUILDING FINAL SURVEY METHODS

The building termination surveys consisted of:

- Dividing the floor and walls up to two meters above the floor of Building 235 annex into one-meter grids.
- Dividing the floor and walls of Building 237 (the shed) into one-meter grids.
- Performing a 100 percent beta scan of all surfaces.
- Collecting five surface alpha/beta measurements, one gamma exposure rate measurement at one-meter from the surface, and one smear from each grid.
- Collecting 250 alpha/beta measurements, 50 gamma exposure rate measurements, and 50 smears on the ceiling and overhead horizontal surfaces in the annex of Building 235.
- Collecting 50 alpha/beta measurements, 15 gamma exposure rate measurements, and 15 smears on the ceiling and overhead horizontal surfaces in Building 237.
- Collecting ten alpha/beta measurements in front of the overhead door on the north side of Building 235 annex.

The gridding for the buildings is shown in figures ? through ?.

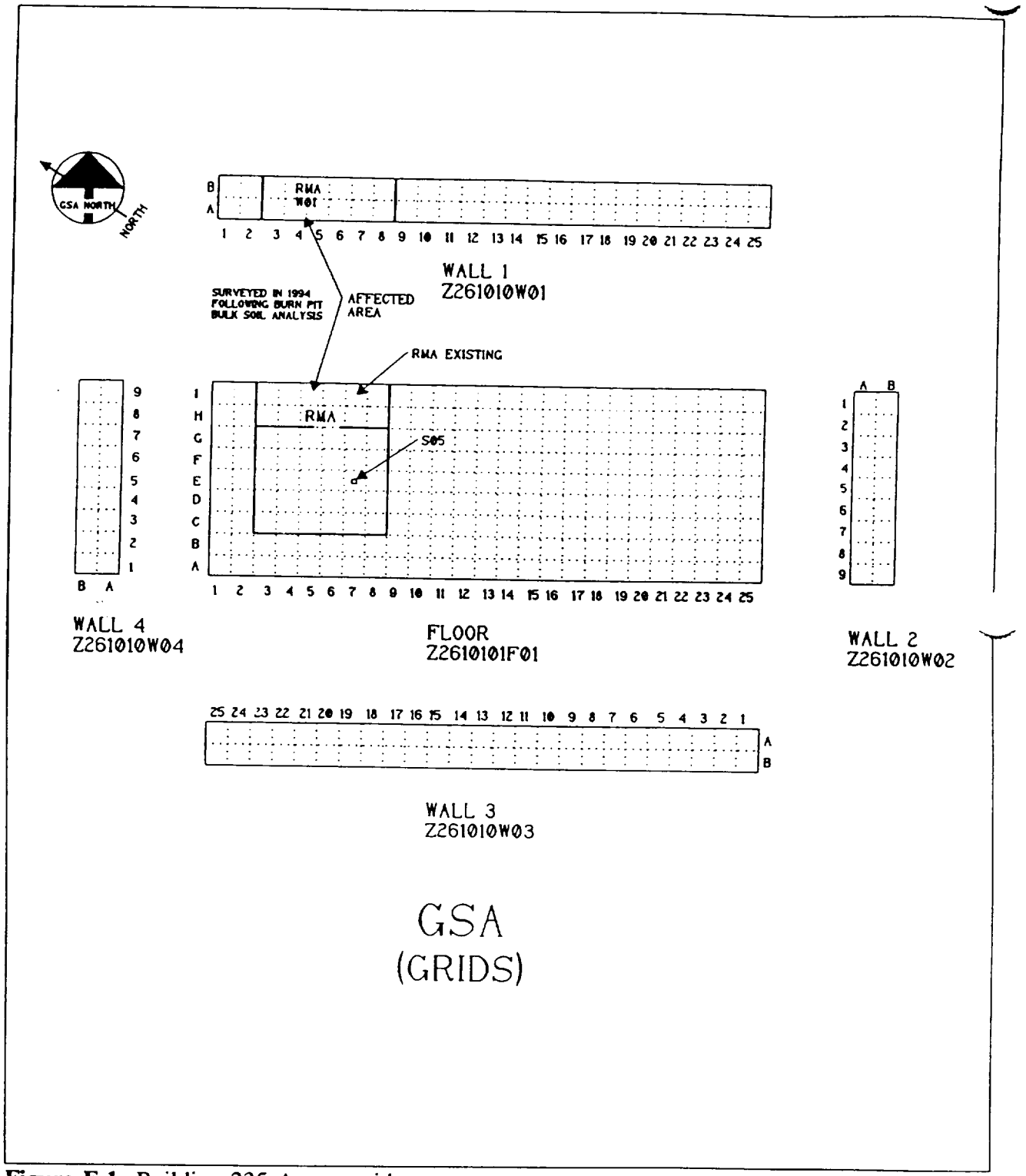


Figure F-1. Building 235 Annex grids

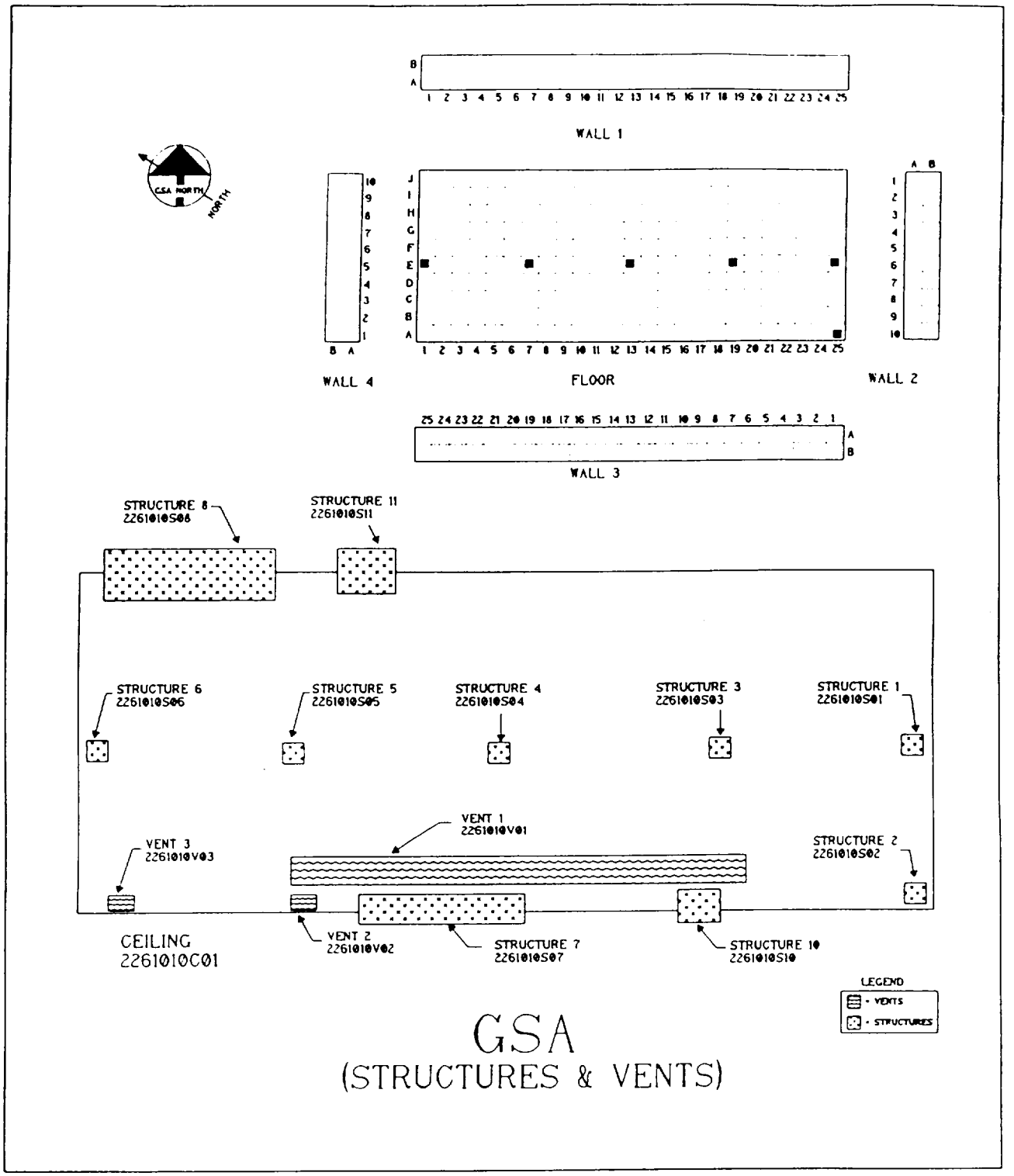


Figure F-2. Building 235 Annex structures & vents

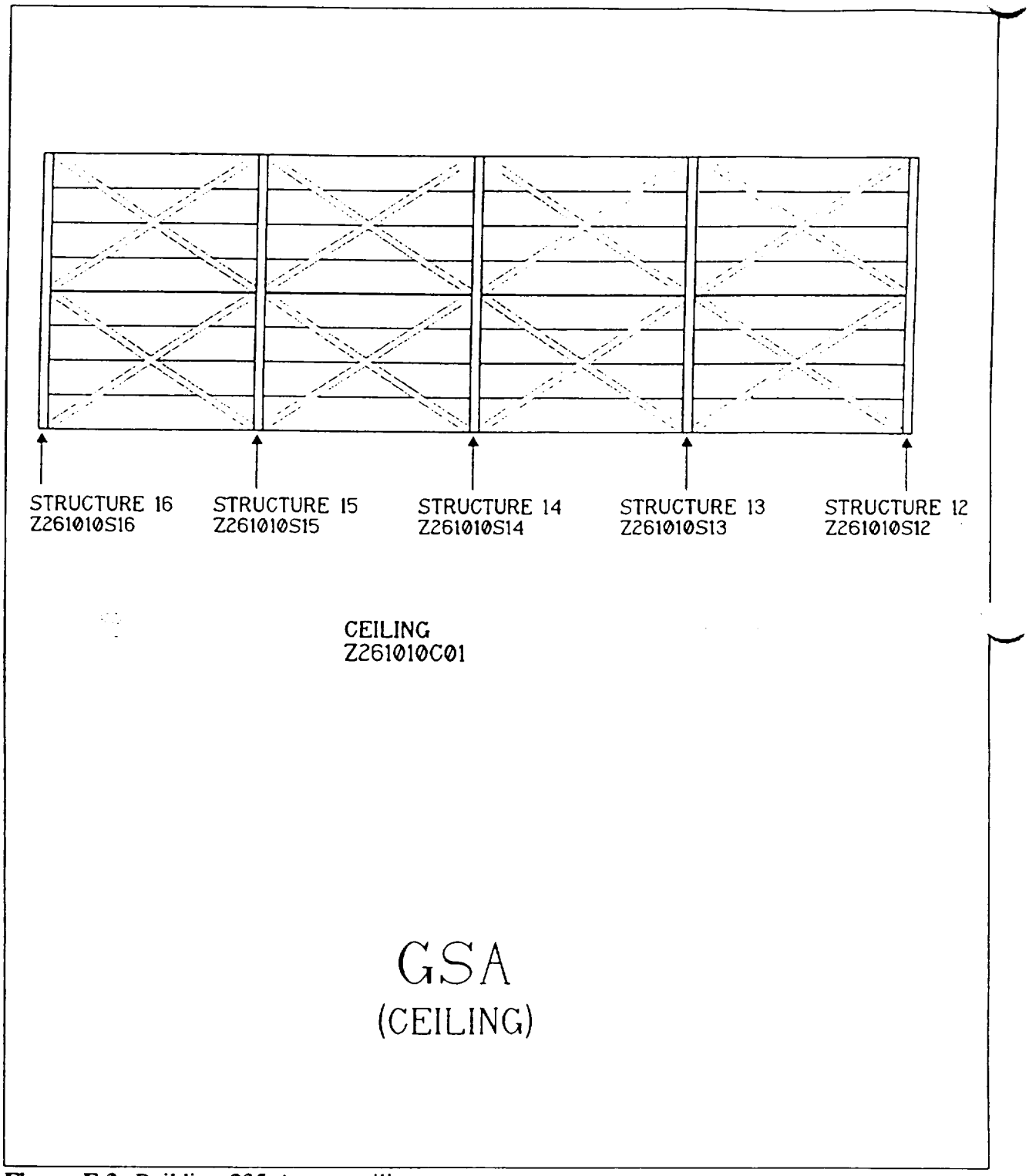


Figure F-3. Building 235 Annex ceiling

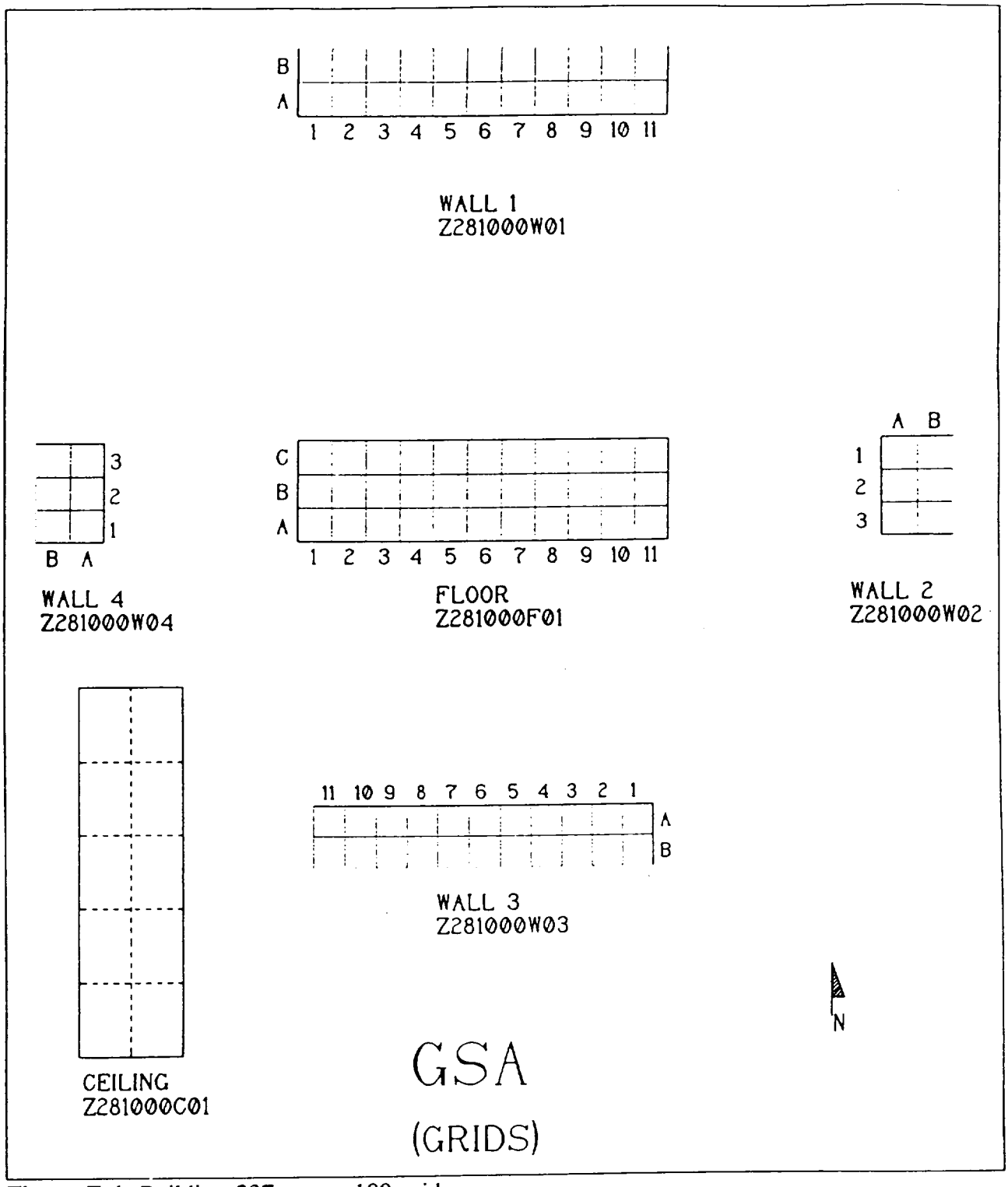


Figure F-4. Building 237, room 100 grids

2. BUILDING 653 (PUMPHOUSE) FINAL SURVEY METHODS

Gamma Exposure Rate measurements were made at 57 locations.

Direct alpha/beta measurements were made at 369 locations.

Gridding for the pumphouse final survey is shown in Figure F-5.

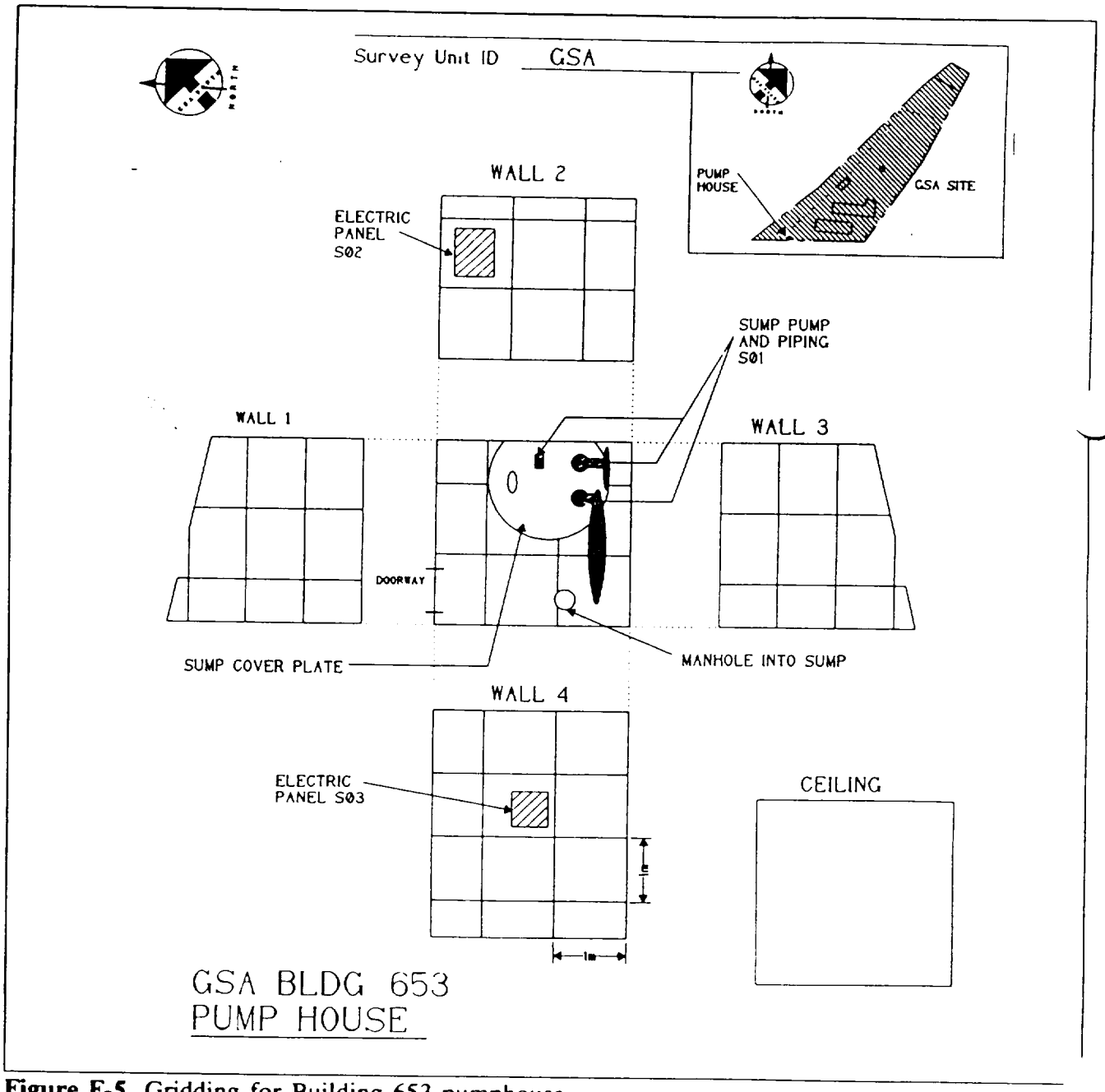


Figure F-5. Gridding for Building 653 pumphouse

3. MANHOLE FINAL SURVEY METHODS

The manhole survey consisted of:

- Collecting and analyzing two sediment samples from two unlabeled sewer manholes outside of Building 235. These samples were not dried due to potential biological hazards.

- Collecting and analyzing one water sample from manhole #147; sediment was not available due to flowing water in this manhole.

Locations of the manholes are shown in Figure F-6.

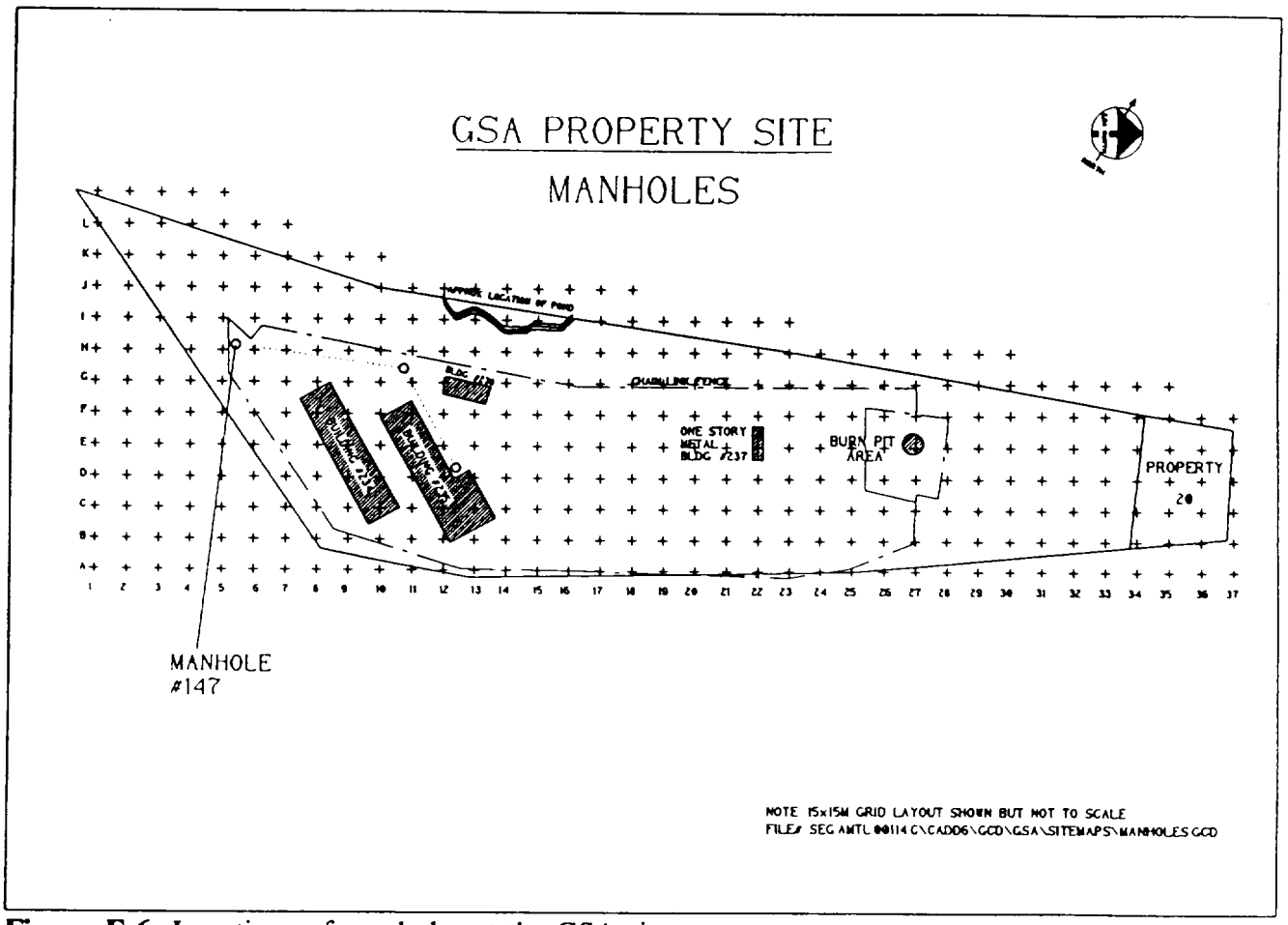


Figure F-6. Locations of manholes at the GSA site

APPENDIX F
MK & SEG: METHOD FOR CALCULATING DEPLETED URANIUM OR URANIUM PLUS DAUGHTERS BASED ON TH-234, RA-226, AND U-235

APPENDIX J
METHOD FOR CALCULATING DEPLETED URANIUM OR URANIUM PLUS DAUGHTERS BASED ON TH-234, RA-226, AND U-235

1.0 PURPOSE

The purpose of this document is to describe the logical process used to determine the amount of depleted uranium or uranium plus daughters in a sample of depleted uranium. The process is based on analysis of the 186 keV peak in a gamma spectrum. The result will be assigned to either uranium-235 or radium-226.

2.0 DISCUSSION

The concentrations of Th-234, U-235 and Ra-226 in samples of soil bearing DU or U+d can be analyzed with a high resolution gamma spectrometer (laboratory or field based).

If the concentration of DU and/or U+d in the sample is low, the gamma spectrometer cannot differentiate between Ra-226 and U-235 in the sample. Unfortunately, this occurs near the acceptable limits of concentration.

The confusion occurs because Ra-226 and U-235 both emit their most significant gamma ray at a peak energy of ~186 keV. Ra-226 has no other significant gamma peak; U-235 has other peaks of low yield at 143.5 and 16. keV. When the concentrations of the nuclides are low, the 186 keV peak result is often reported as both Ra-226 and U-235, though it can be reported as either one.

When the concentration of U-235 in the sample is high enough, the gamma spectrometer can identify and quantify the 143.8 keV (and sometimes the 163.3 keV peak), thus providing a mechanism to properly split the 186 keV result between U-235 and Ra-226, giving correct answers for both nuclides.

If the 143.8 keV peak is not detected in the spectrum, the question is, how to tell whether the sample contains only U-235, only Ra-226, or both?

In DU, the ratio of Th-234 to U-235 is fixed and known. The concentration of Th-234 can be measured independently of the U-235. Thus it is possible to calculate the expected result for U-235 once the concentration of Th-234 is measured.

Subtracting this value for U-235 from the result reported via the 186 keV peak measurement, gives us the amount of the 186 keV peak to assign to Ra-226, and the concentration of Ra-226, when an appropriate yield factor is introduced. Thus we can assign the area of the 186 keV peak to U-235, or Ra-226, or a mixture of the two, by measuring the Th-234 and the 186 keV line.

3.0 BASIS FOR DECISION

If the analysis of the 186 keV peak is not determined to be U-235 by virtue of the existence of a 143.5 keV peak, then the decision of whether the peak area should be assigned to Ra-226 or U-235 will be based on the value of an estimated Ra-226 result if it exceeds the error in the estimated Ra-226 (exceeding Critical Level).

4.0 DECISION PROCESS

The decision process is a function of the analysis techniques and reporting practices of the gamma spectroscopy software employed for sample analysis. This document is based on the use of Canberra Industries Genie-PC gamma spectroscopy software.

The gamma spectroscopy software configuration can produce reports for the 186 keV peak which identify it in the following ways:

- As U-235 and Ra-226 when both are present in the sample;
- As U-235 and Ra-226 when only one nuclide is present. This is the most common form of report;
- As U-235 (verified by the presence of the 143.5 keV peak);
- As U-235 when the source really is U-235 (but the 143.5 keV peak is not reported);
- As U-235 when the source really is Ra-226;
- As Ra-226 when the source really is Ra-226;
- As Ra-226 when the source really is U-235;

Table J-1 shows the actions needed to generate an appropriate result when the nuclides of interest are reported with values above zero, in their various combinations. Not all permutations of the variables are shown here, because some of them are not viable under these circumstances, and are irrelevant to the discussion.

Table J-1 - Actions Required to Produce an Appropriate Answer for DU and U+d Calculations

Nuclides reporting > zero concentration			**Uranium verified by 143.5 keV peak**	**Action required to assign 186 keV peak to Ra-226, U-235, or both**
Th-234	Ra-226	U-235		
Y	N	Y	Y	Use values as reported.
Y	Y	Y	Y	Use values as reported.
Y	N	Y	N	Calculate estimated U-235, Ra-226, and their errors. Perform Critical Level test for Ra-226 to assign portions of the 186 keV peak area.
Y	Y	N	N	Calculate estimated U-235, Ra-226, and their errors. Perform Critical Level test for Ra-226 to assign portions of the 186 keV peak area.
Y	Y	Y	N	Calculate estimated U-235, Ra-226, and their errors. Perform Critical Level test for Ra-226 to assign portions of the 186 keV peak area.
Y	N	N	N	Use values as reported.
N	Y	N	N	Use values as reported.
N	N	N	N	Use values as reported.
N	N	Y	N	Calculate Ra-226 concentration and error values from the U-235 values. Report Ra-226 values and set U-235 to zero.[1]
N	Y	Y	N	Use Ra-226 concentration and error values as reported. Set U-235 to zero.

The logical steps required to implement the actions described in Table J-1 are described below, in gross form. The calculation of estimated values for U-235, Ra-226, and their uncertainties (errors) is described later, with the Ra-226 Critical Level test.

Logic to Generate Results from Gamma Spectrum Analysis

If a U-235 143.5 keV peak is present then use reported values for nuclides;

otherwise, If there is no 143.5 keV peak available, then

If no thorium-234 result is present, then

If both Ra-226 **and** U-235 are reported then, do not report U-235 (set it to zero),

Otherwise, if only U-235 is reported, then

Calculate and report equivalent Ra-226, set U-235 to zero,

otherwise, only Ra-226 is reported, then

Use reported values for Ra-226

otherwise, Thorium-234 was reported, then

Calculate estimated U-235 and Ra-226,
Perform Ra-226 Critical Level test and calculate amount of material, and
Use computed values for nuclides.

The processes required to perform the functions to:

- Calculate Estimated U-235 and Ra-226;
- Perform Ra-226 Critical Level test and calculate amount of material

are described below:

4.1 Calculate Estimated U-235 and Ra-226

The inputs to this calculation are the reported concentrations of Th-234 and Ra-226.

- Calculate the **Estimated U-235**, based on the Th-234 value reported by Genie-PC, i.e.

  (Th-234/52.5);

- Convert the reported Ra-226 to interim U-235, by dividing Ra-226 by 16.43;

- Subtract the Estimated U-235 from the Interim U-235 to obtain the Excess U-235;

- Convert the Excess U-235 back to **Estimated Ra-226** by multiplying Excess U-235 by 16.43;

- Compute the error for the Estimated U-235 and Estimated Ra-226 by the square root of the sum of the squares of the errors method.

4.2 Perform Ra-226 Critical Level Test and Calculate Amount of Material

The inputs to this calculation are the Th-234 value, the Estimated U-235 and Estimated Ra-226 values and their errors, from the above calculations.

The Critical Level is the 95% confidence level error associated with the result for Estimated Ra-226.

- If the Estimated Ra-226 exceeds the Critical Level, then calculate and assign the material as U+d, otherwise calculate the material as DU;

- If the material is DU, then calculate the amount of DU as, 1.47 x Th-234;

- If the material is U+d, then calculate the amount of U+d from, 2 x Th-234 + Estimated Ra-226 + Estimated U-235;

- If the material is DU, then calculate the error in the amount of DU from, 1.47 x Th-234-error;

- If the material is U+d, then calculate the error in the amount of U+d from:

  Square Root of { [Estimated Ra-226-error]^2 + [2 * Th-234-error]^2 +
  [Estimated U-235-error]^2 };

  Note: The errors reported by the Genie PC are at the 95% confidence level.

(1). U-235 cannot exist without Th-234 being present. Thus, if U-235 is reported with zero Th-234, then we conclude that it is really Ra-226.

APPENDIX G

ATSDR PUBLIC HEALTH ASSESSMENT
(SELECTED PAGES)

PUBLIC HEALTH ASSESSMENT

MATERIALS TECHNOLOGY LABORATORY (U.S. ARMY)

WATERTOWN, MIDDLESEX COUNTY, MASSACHUSETTS

CERCLIS NO. MA0213820939

ARMY SECTION
FEDERAL FACILITIES ASSESSMENT BRANCH
DIVISION OF HEALTH ASSESSMENT AND CONSULTATION
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

December 26, 1995

Mr. Dennis Waskiewicz
U.S. Army Corps of Engineers
424 Trapelo Road
Building 112S
Waltham, MA 02254-9149

Dear Mr. Waskiewicz:

Enclosed please find a copy of the Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment-Public Comment Release for the Materials Technology Laboratory (U.S. Army), dated December 26, 1995. This document is ATSDR's evaluation of data and information on the release of contaminants into the environment from the Materials Technology Laboratory (U.S. Army), Watertown, Middlesex County, Massachusetts. The purpose of this document is to assess any current or future impact on public health.

The ATSDR will accept written comments from the public until February 12, 1996. Comments should be addressed to: Chief, Program Evaluation, Records, and Information Services Branch, Division of Health Assessment and Consultation, ATSDR, 1600 Clifton Road NE, Mailstop E-56, Atlanta, Georgia 30333.

If you have any questions, please do not hesitate to call Lorna Bozeman, the health assessor, at (404) 639-6070.

Sincerely yours,

Max M. Howie, Jr.
Chief
Program Evaluation, Records,
and Information Services Branch
Division of Health Assessment
and Consultation

Enclosures

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the Agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited timeframe. To the extent possible, it presents an assessment of the potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30 day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

Agency for Toxic Substances and Disease Registry.....David Satcher, M.D., Ph.D., Administrator
Barry L. Johnson, Ph.D., Assistant Administrator

Division of Health Assessment and Consultation.....Robert C. Williams, P.E., DEE, Director
Juan J. Reyes, Deputy Director

Exposure Investigations and Consultations Branch.....Edward J. Skowronski, Acting Chief

Federal Facilities Assessment Branch.....Sandra G. Isaacs, Acting Chief

Petitions Response Branch.....Cynthia M. Harris, Ph.D., Chief

Superfund Site Assessment Branch.....Sharon Williams-Fleetwood, Ph.D., Chief

Program Evaluation, Records, and Information Services Branch.....Max M. Howie, Jr., Chief

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

Please address comments regarding this report to:

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Attn: Chief, Program Evaluation, Records, and Information Services Branch, E-56
1600 Clifton Road, N.E., Atlanta, Georgia 30333

FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports

identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When infomed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The U.S. Army Materials Technology Laboratory (MTL) was added to the U.S. Environmental Protection Agency's Superfund National Priorities List (NPL) on May 30, 1994. The 37 acre MTL facility is part of what was originally the Watertown Arsenal, established in 1816. MTL is in Watertown, Massachusetts, approximately 5 miles west of Boston. The facility's inclusion on the NPL was largely based on the potential for site contaminants to migrate into the Charles River, which is about 100 yards south of the installation border. (1) ATSDR involvement at MTL stems from the facility's inclusion on the NPL and requests by community members that our agency evaluate public health issues at the former Watertown Arsenal and other sites in Watertown (see Appendix A). Specific health concerns raised by Watertown residents are discussed in the Community Health Concerns section of this report.

Environmental contamination at MTL, and associated former Arsenal properties, resulted from a long history of munitions and arms manufacturing and related operations, and materials research. (1,2) Although other contaminated former Arsenal properties are not included on the NPL, they are considered in our public health assessment. Those properties include the Formerly Used Defense Site (FUDS) parcel, which is now the Arsenal Mall (also referred to as the Arsenal Marketplace) and Arsenal Park, and the General Services Administration (GSA) site.

ATSDR evaluated the environmental information for all properties comprising the original Watertown Arsenal (Figure 1). Appendix A describes our evaluation of these parcels. As a result of this review, we identified several potential situations where people currently could be exposed to contaminants, could be exposed to site contaminants in the future, or could have been exposed to site contaminants in the past. These potential exposure situations relate to: 1) contaminated subsurface soil and building remnants on the FUDS parcel; 2) suspected fish contamination in the Charles River, and; 3) past air releases of depleted uranium. Other situations were evaluated where exposures might result from future use of properties that are currently contaminated. These exposure situations are grouped below by ATSDR Public Health Assessment Conclusion Categories, which are defined in Appendix B.

POTENTIAL (INDETERMINATE) HEALTH HAZARDS: MORE DATA NEEDED

We conclude that two situations pose <u>potential</u> public health hazards:

1) Subsurface Contamination - People are not currently being exposed to contaminants on the FUDS parcel, but future exposures are possible if workers

unearth contaminated subsurface soils and building remnants potentially containing radiologically-contaminated piping. Further, it has not yet been determined if portions of the sewer system that were once connected to former Arsenal buildings 34, 41 and 421 are radiologically contaminated and if these areas are accessible to public works employees. ATSDR recommended that the Army implement measures to ensure that people are not exposed to potentially hazardous levels of residual radiologic and chemical contamination, which resulted from former Arsenal activities, on what is now the FUDS parcel. (5,6)

2) Fish in the Charles River - Chemicals known to bioaccumulate in edible fish species have entered the Charles River from multiple industrial and urban sources in the Watertown area, including the former Arsenal. People who eat fish caught in urban stretches of the Charles River could, therefore, be exposed to contaminants in fish tissue. ATSDR recommended fish sampling in the river, (3,4,5) which the Massachusetts Department of Environmental Protection conducted during the fall of 1995 in coordination with the state fish toxics program. (7,8) The Massachusetts Department of Public Health, the agency responsible for issuing fish advisories, will review that data to determine if followup public health action is needed. (8)

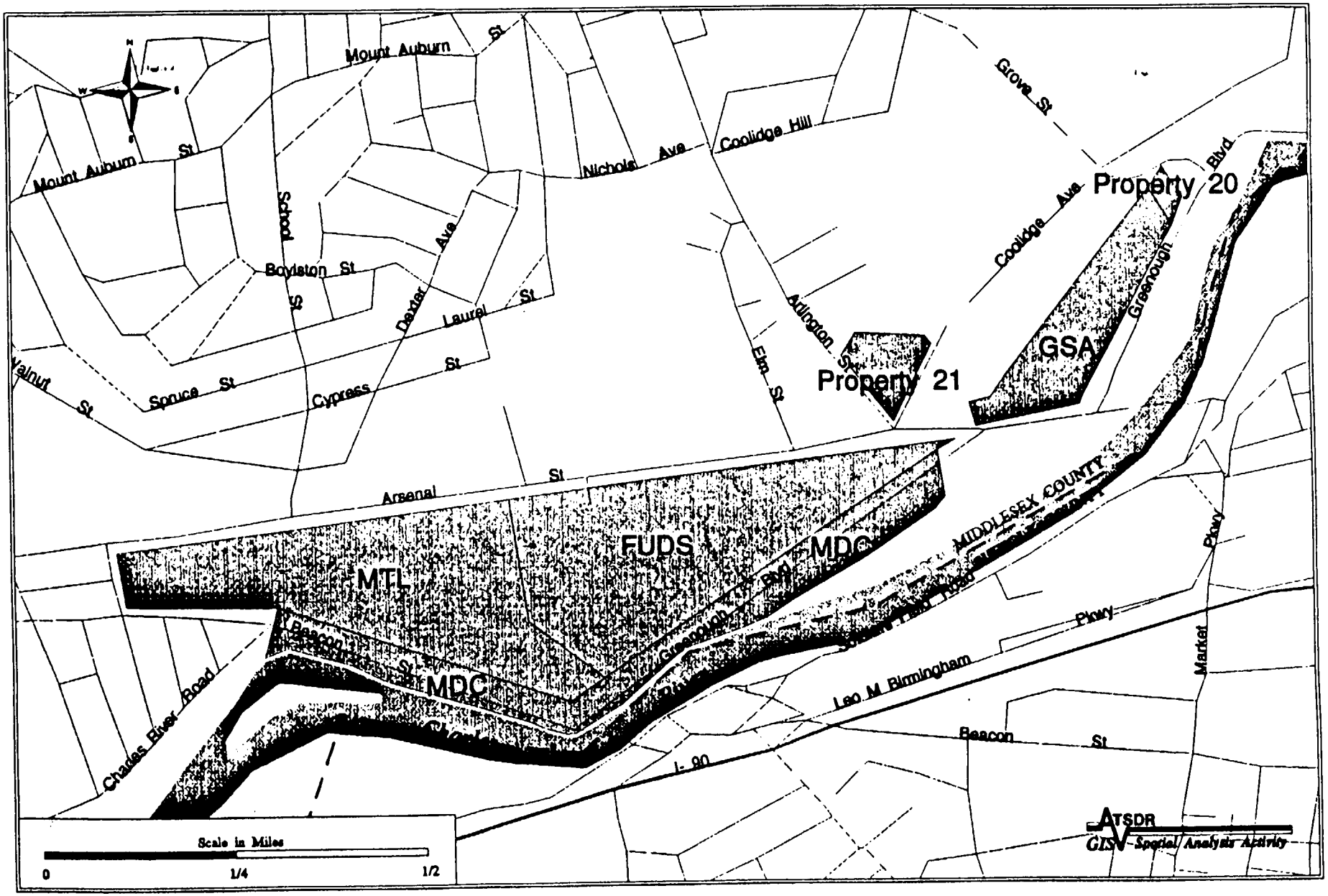
NO APPARENT HEALTH HAZARD

ATSDR concluded that two other situations were no apparent public health hazard:

1) In the situation where depleted uranium was burned at the Watertown Arsenal in the past, possible exposure to airborne contaminants was below levels of health concern. Radiation dose estimates, based on very protective assumptions, showed a lifetime cancer risk less than that expected from background radiation levels.

2) In the situation regarding MTL and GSA land use, current site conditions (e.g., access by the general public is restricted) make it unlikely that people would be exposed to contaminants at levels of health concern. Moreover, before these properties can be released for reuse, residual contamination must be cleaned up to levels considered protective of public health according to guidelines set by state and federal regulatory agencies.

FIGURE 1: Former Watertown Arsenal, Watertown, MA



II. NO APPARENT HEALTH HAZARDS

A. Past Air Releases of Depleted Uranium

Although depleted Uranium (DU) was burned at the Arsenal in the past, the amount of DU released to air was unlikely to be at levels considered harmful to residents of the surrounding community. There were few, if any, community members living close enough to the Arsenal to have been exposed to airborne DU in the past. Very conservative assumptions were used in the radiation dose estimates. We assumed burning occurred 8 hours a day, 365 days per year, for a maximum of 20 years. Based on these assumptions, the lifetime cancer risk was less than the risk of cancer expected from background levels of radiation. The MDPH review of cancer incidence for Watertown (34) showed no observed increase in cancer rates plausibly associated with radiation exposure.

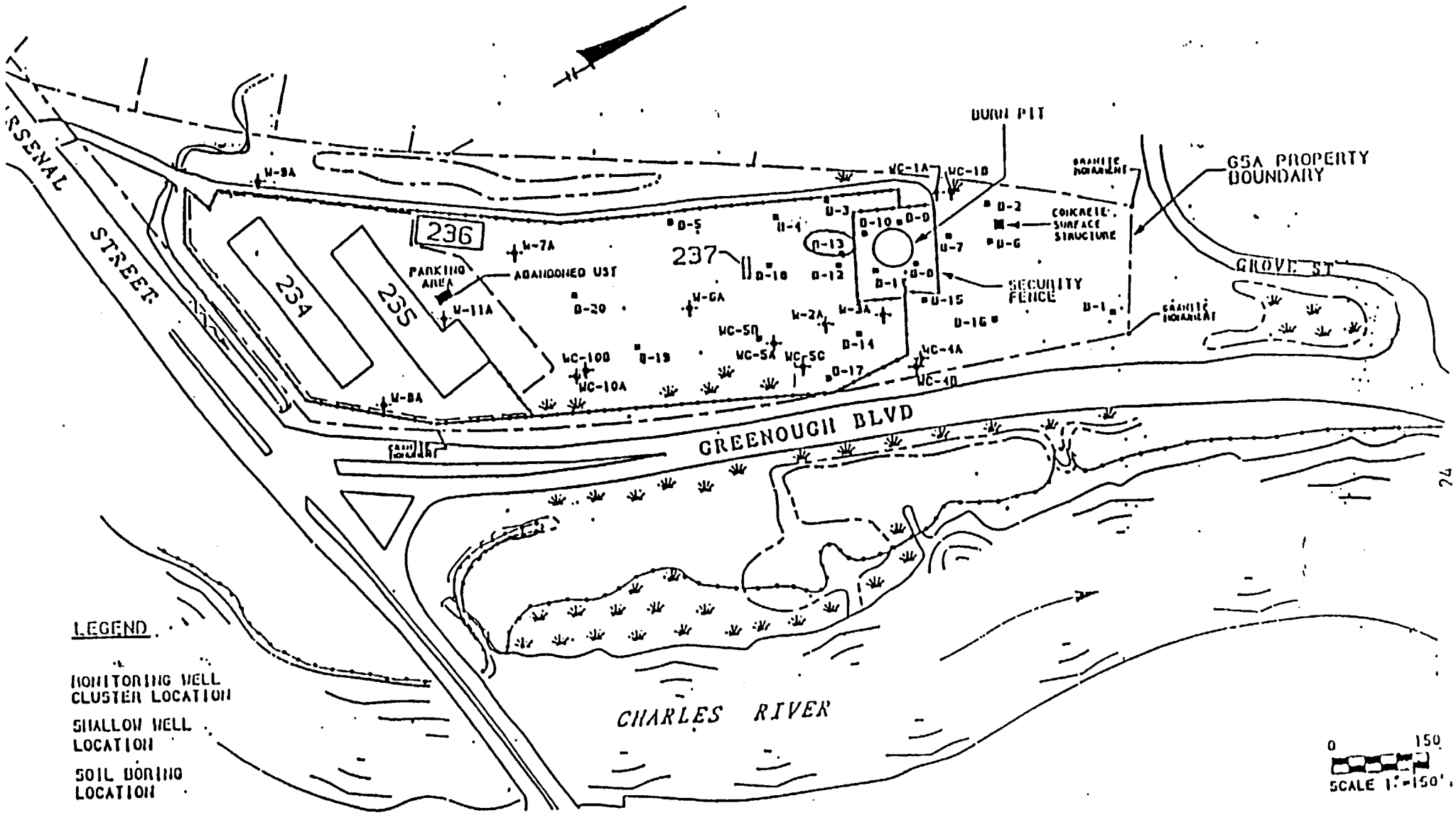
Controlled incineration of depleted Uranium chips was done because of the pyrophoric properties of the metal. The incineration not only prevented the chips from spontaneously igniting but also reduced the volume of DU waste requiring disposal at Atomic Energy Commission (AEC) licensed facilities and, after 1974-1975, Nuclear Regulatory Commission licensed facilities. (36) The DU was initially burned in a remote part of Watertown (GSA site), away from residential areas. Later, DU was incinerated in building 43 (MTL) where air releases occurred from a stack near the east end of the building. Detailed information about DU burn activities at both the GSA site and building 43 are provided below.

GSA site - Northeast Area

Incineration Practices: Depleted Uranium was incinerated in a fenced area at the Northeast Area, which is now the GSA site, from 1955 to 1967 (Figure 6). (13) During the time period when the burn pit was used it was in a remote area, away from residences. Procedures were implemented to prevent exposure of personnel to airborne radioactivity. These procedures are described in Appendix D-1. (36) A December 23, 1966 letter from the Arsenal (AMRA) to the Atomic Energy Commission (AEC) reported air sampling results for Uranium oxidation procedures. Although numerical data were not provided, the letter indicates that average Uranium concentrations in smoke generated by oxidation were below limits set in the federal regulations in place at that time. (13) The 1966 AEC limit for air releases in unrestricted areas was 5×10^{-12} μCi/ml for Uranium-238, which is the predominant isotope in DU. This level is applicable for both soluble and insoluble Uranium compounds and assumes constant exposure. The limit in place at that time would result in a whole-body dose of 0.5 rem/year (500 mrem/y) to the general populace and considers the potential presence of children in the group.

Based on these data, air releases of DU from the GSA site were not at levels of health concern.

FIGURE 6. GSA Site



Reference: Modified from Figure B-1, SEG, Radiological Survey Report (26)

Human Exposure: We do not expect that people off site were exposed to significant concentrations of airborne Uranium oxides. The residential areas that now border the western edge of the GSA property, were built after burning ceased. Aerial photographs from 1968 show no housing in the site vicinity. (13) Because DU is extremely dense, particles carried in smoke would quickly settle to the ground in the general proximity of the burn pit. Conceivably, very small particulates could disperse at greater distances from the source. However, deposition of these fine particles would be widely scattered, and consequently, measurable amounts of DU would not occur in localized areas distant from the source. *Therefore, significant amounts of fugitive DU particulates in smoke would not be expected to have drifted far off site. Even in the unlikely event that people off site did inhale DU particulates, exposures would have been rare and, based on available air dispersion data, the resulting dose to the lung would have been below health concern.*

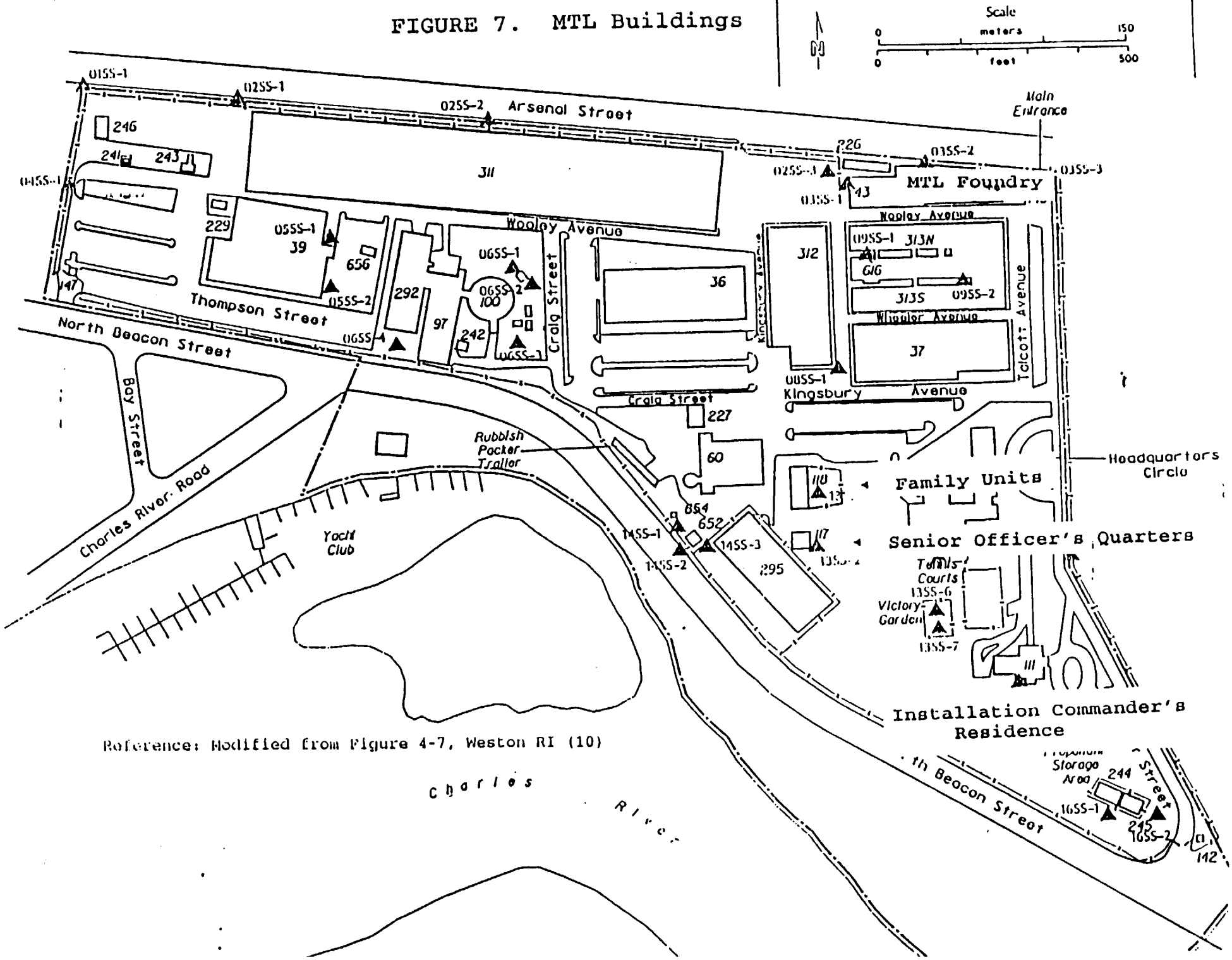
Radiological surveys to determine the extent of contamination at the GSA property are in progress. The results reported thus far confirm that radiologic contamination is primarily confined to surface soil in discrete, on-site areas. Contamination is not widespread and buildings on the GSA land meet requirements for unrestricted use. (37)

Residual soil contamination on both the GSA property and adjoining Property 20 does not pose a health threat to people who live in areas adjacent to the site. Access to potentially contaminated areas is restricted by fences surrounding the burn pit, the GSA property boundary and the portion of Property 20 where fill was placed. (38) Additional survey work is planned to complete the evaluation and portions of the GSA property where DU levels in soils exceed the health-based standard of 35 pCi/gram will be cleaned up. (37)

Building 43 - Foundry on MTL

Incineration Practices: The Arsenal began burning depleted Uranium in an incinerator in the MTL Foundry (building 43) (Figure 7) after the GSA property was no longer used for that purpose. Although records could not be located that indicate when the incinerator was first used, most DU burns occurred in the 1970s and early 1980s. Engineering controls to reduce the amount of DU released to the outside air were not installed on the incinerator until 1981. By the mid to late 1980s, DU was burned infrequently, and by July 1992, DU was no longer burned at the Arsenal. (39,40) In the past, uncontrolled DU fires also occurred in the Foundry building.

FIGURE 7. MTL Buildings



Reference: Modified from Figure 4-7, Weston RI (10)

Human Exposure: To estimate the potential radiation dose resulting from DU released from building 43, we reviewed available air sampling data. The Arsenal had limited stack monitoring data, spanning from 1981 to 1991 (Appendix D-2). After 1981, the amounts of DU released from the stack dropped dramatically. Because the data were not complete, we made several assumptions prior to calculating dose estimates. The 1981 air data were used in the dose estimates. These data represent the greatest amounts of material released from the stack considering no earlier data could be found. (41)

We also assumed that DU burns occurred 8 hours per day, every day of the year. However, these values probably overestimate the actual duration and rate of burning. Arsenal records from 1972 to 1977 indicate that DU burns usually lasted about 2 hours and occurred 5 times or less a month. (42) The reported volume of air handled by the system ranged from about 400 to 1265 ft^3 per minute. (43) From these very conservative assumptions, the total amount of DU and products released from the stack was estimated. The estimated totals for 1981 were between 84 and 267 millicuries (mCi) of Uranium-238 and 217 to 685 mCi of Thorium-234 (a decay product of U-238).

Once the total amounts of radioactive materials released were estimated, ATSDR performed a probability analysis, based on 10,000 trials, to estimate the most probable amount of material released from the stack. These values were then entered into the CAP88-PC radiological assessment software package. (44) CAP88-PC estimates the risk and dose from radionuclides released through the air. Its use is required in 40 CFR 61.93(a) [Code of Federal Regulations], in compliance with the Clean Air Act, when calculating radiation doses to the public.

The results indicate that the maximum effective dose equivalent (EDE) resulting from DU incineration was less than 200 mrem per year (mrem/y), whole body, to an individual living within 200 meters of building 43 in 1981. As the distance one lived from the Arsenal increased, the effective dose decreased. The maximum calculated whole body dose was within the 500 mrem/y federal limit in place in 1981. (24) Even though the current federal limit is 100 mrem/y, (45) we do not consider the estimated doses to be a health hazard since very protective margins of safety were used in setting these limits and in the dose calculations. The 100 mrem/y limit assumes a member of the general public is exposed to these levels every day for 70 years; however, 500 mrem/y is still permitted for infrequent exposures. Moreover, the occupational annual limit is 5000 mrem/y and no known adverse health effects have been reported at that level. (45)

Cancer Risk: The CAP88-PC model also develops cancer risk estimates related to the estimated radiological dose summed for all radionuclides entered into the model, in this case, U-238 and Th-234, the major radionuclides present in DU. The estimates are given for several organ systems and the whole body. Uranium-238, for the purposes of radiation dosimetry, is considered to be uniformly

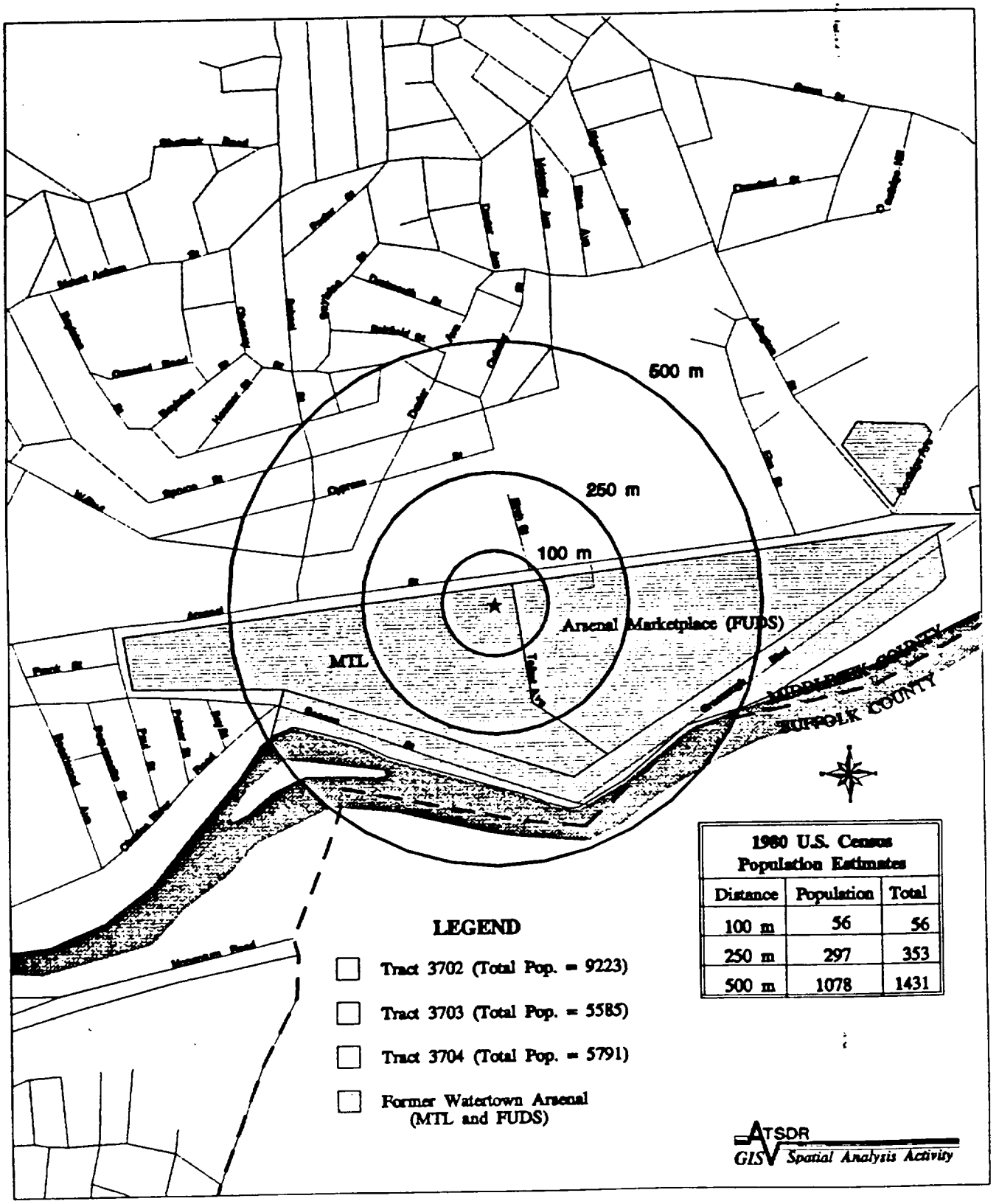
distributed throughout the bone. Thorium-234, however, is considered to be uniformly distributed over the bone surface (46). Therefore, the critical organs affected would be both the bone surface and the red marrow within the bone interior, and the lungs which are the point of entry. However, lung cancer would comprise virtually all the risk from this form of exposure. The data from our CAP88-PC calculations indicates that the exposure to the entire body was less than 200 mrem per year. This equates to a lifetime cancer mortality risk that is 10 times less than the risk expected from 70 years of exposure to natural radiation in the environment. (47)

Population Exposed: Based on the modeling, maximum exposure would have been to people living within 200 meters of building 43. The nearest residential areas, which are about 200 meters from building 43, are on MTL and on the FUDS parcel to the east.

Figure 8 (1980) and Figure 9 (1990) show population estimates within 100, 250 and 500 meters of building 43. These estimates are based on census data, assume even distribution of the population within each census subgroup, and extrapolate the percentage of the census subgroup within each concentric circle. These figures probably underestimate the actual number of people who live closest to building 43. Condominiums and apartments, built on redeveloped former Arsenal property, are within 200 meters east of building 43. However, these residential areas were not built until the early 1980s, by which time air releases of depleted uranium from building 43 were significantly reduced. The condominium complex is comprised of an original Arsenal building (building 212) that was renovated and two newer buildings. The Arsenal Apartments, housing for the elderly, includes a five-story apartment building and several renovated former Arsenal buildings (buildings 71, 72 and 73). (13)

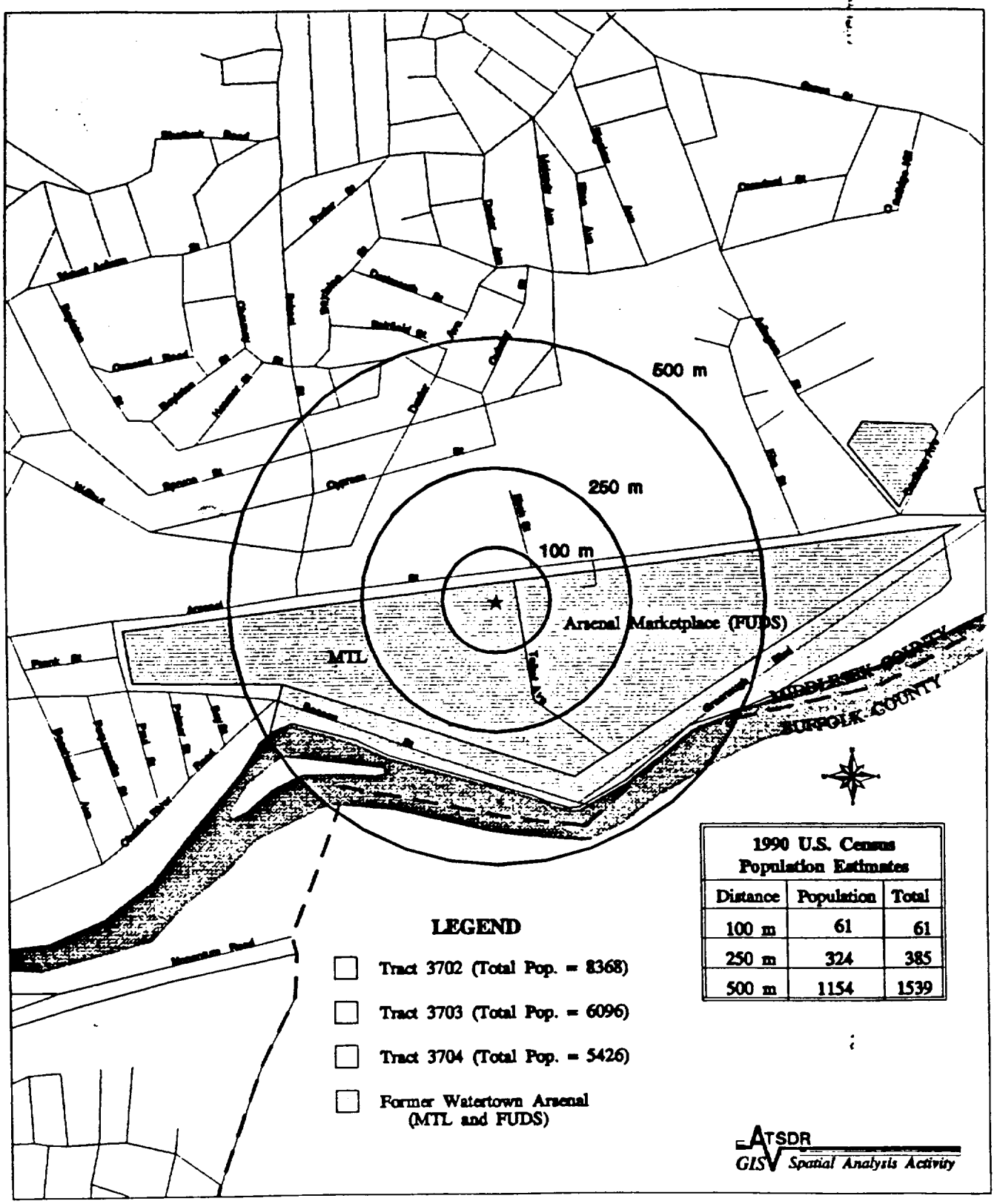
The three buildings on the MTL facility that were used for housing are roughly 250 meters or more from building 43. (Figure 7) Building 111 was the Installation Commander's residence, building 117 was a four-bedroom senior officer's quarters, and building 118 comprised five two-bedroom family units. The average length of residence in any of these military housing units was 2 to 3 years. (48)

FIGURE 8. Population Estimates Around the Former Watertown Arsenal
Source: 1980 U.S. Census



1980 U.S. Census Population Estimates		
Distance	Population	Total
100 m	56	56
250 m	297	353
500 m	1078	1431

FIGURE 9. Population Estimates Around the Former Watertown Arsenal
Source: 1990 U.S. Census



1990 U.S. Census Population Estimates		
Distance	Population	Total
100 m	61	61
250 m	324	385
500 m	1154	1539

Health Effects of Particulates: Inhaled particulates penetrate different regions of the respiratory tract based mainly on their size (also referred to as activity mean aerosol diameters [AMAD]). It is the very small DU particulates released to air that are of greatest concern from an exposure standpoint, because they can be inhaled deep into the lung (Table 2).

Table 2. Respiratory Deposition of Uranium Oxide Particulates (46)

Respiratory Deposition	Percent Deposition by Particle Size (μ)		
	5μ	1μ	0.3μ
Nasopharyngeal (Nose)	74	30	9
Tracheal Bronchial Tree (Throat)	8	8	8
Pulmonary Parenchyma (Lung)	9	25	43

The airborne material produced from burning DU is UO_2 and U_3O_8; relatively insoluble uranium oxides. These uranium oxides are class Y compounds, which have an estimated lung retention time of greater than 100 days because they are not very soluble in lung fluids. (46) This means that they stay in the lungs for an extended period of time before being distributed throughout the body. The majority of uranium oxide particulates deposited deep in the lung are smaller than 0.3 μ. Particles ranging in size from 0.3μ to 5μ also add to the lung burden, but to a lesser extent. And finally, less than 10% of particles with AMAD greater than 5 μ penetrate into the deep lung region. (46) Particles deposited in the nose and throat are usually expelled from the upper air ways and ingested. Because these ingested particulates are uranium oxides, which are relatively insoluble, they pass through the digestive system and are excreted fairly rapidly.

The 1981 air data used in the radiation dose estimation model is from the time period after engineering controls reduced the amount of DU released to outside air. However, releases of fine DU particulates (less than 0.3 microns [μ]) to air during burning in 1981 and after, were most likely comparable to earlier years. Although the use of high efficiency particulate air (HEPA) filters on the incinerator decreased air releases of particulates greater than 0.3 μ in size, fine particulates continued to be emitted. As discussed earlier, using data representing the greatest amounts of material released from the stack and incorporating assumptions that are very protective of public health, the maximum estimated radiation dose was not at levels which pose a public health hazard.

Conclusions and Public Health Action Plan for Past Air Releases of Depleted Uranium

Conclusions:

1. The amount of depleted Uranium (DU) released to air from MTL and the GSA site was unlikely to be at levels considered harmful to residents of the surrounding community. Few, if any, residents lived close enough to sites to have been exposed. Further, radiation dose estimates, based on very protective assumptions, showed a lifetime cancer risk less than that expected from background radiation levels.

2. Members of the general public are not likely to contact residual DU contamination at either the GSA site or the MTL property because access to contaminated areas is restricted.

Completed Actions:

1. The Army has restricted access to areas of the GSA and MTL properties where there is residual DU contamination.

Planned Actions:

1. The Army is continuing radiation survey work at the GSA site and is planning to cleanup DU levels in soil to the health-based standard of 35 pCi/gram. Cleanup of MTL building 43, which housed the DU incinerator, is also being completed to meet applicable Nuclear Regulatory Commission requirements.

B. Future Land Use (MTL and GSA site)

Public health issues concerning future land use of MTL and the GSA site (see Figure 1) are of utmost importance and are being actively addressed. Procedures are implemented during sampling and cleanup activities to protect both the general public and remediation workers from possible hazards. Further, before the land can be transferred for reuse, all necessary cleanup actions must be completed.

The Army is conducting site investigations and cleanup at MTL and the GSA site under the guidance of the Commonwealth of Massachusetts Departments of Environmental Protection (MDEP) and Public Health (MDPH), the U.S. Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). These regulatory agencies set cleanup levels that are protective of public health considering the land reuse options that are planned. ATSDR supports these activities by providing technical assistance concerning public health issues as requested. We reviewed the "Human Health Radiological Risk Assessment for Massachusetts 21E Sites" for MDEP and concur that the 10 mrem dose limit proposed for cleanup at MTL is protective of public health. (49) We have also reviewed documentation regarding environmental activities at the former Arsenal properties (GSA site and FUDS parcel) and provided comments to the Army and regulatory agencies concerning issues of public health importance. (5,6,38,50)

Residents who live next to MTL and the GSA site expressed concern about possibly being exposed to contaminants because they see on-site workers wearing personal protective equipment (PPE) during sampling and cleanup activities. However, the use of PPE by remediation workers does not necessarily mean that a site is extremely hazardous; rather, PPE is a required precautionary measure to protect workers from possible hazards encountered during field investigations. Other actions are taken during the course of site cleanup that prevent exposures from occurring. These include restricting access in areas where residual contamination is at levels of public health concern. Fencing and/or security measures are in place at MTL and the GSA site which effectively limit site access. Finally, Site Health and Safety Plans are developed which detail proper safety measures to be followed during all site work. These plans include containment methods to be used during sampling and cleanup activities which prevent contaminated dusts, vapors, etc from moving away from the site.

Conclusions and Public Health Action Plan for Future Land Use of MTL and GSA site

1. Neither MTL nor the GSA site pose a public health threat to members of the general public because exposure to contamination is not likely to occur. The Army has restricted access to areas where there is residual contamination.

2. Actions planned by the Army, in collaboration with state and federal regulatory agencies, will ensure that neither site will pose a future public health hazard. Before the properties can be transferred for reuse, all necessary cleanup will be completed following strict health and safety guidelines.

COMMUNITY HEALTH CONCERNS EVALUATION

Watertown residents discussed their health concerns with ATSDR staff members during meetings held in December 1993 (31) and January 1994 (57). Information about health concerns was also gathered from members of the Watertown Board of Health, the Army, the Massachusetts Departments of Environmental Protection and Public Health, and the U.S. Environmental Protection Agency. Concerns 1-3 relate directly to MTL or other former Arsenal properties, while the other concerns center around environmental contamination in Watertown as a whole.

Concerns associated with the Arsenal:

1. Could long term health effects occur from past exposure to depleted Uranium (DU) that was burned at the Arsenal?

The amount of DU released to air during past burning of depleted Uranium at MTL and the GSA site was unlikely to be at levels considered harmful to residents of the surrounding community. Since significant exposures were not expected, adverse health effects would not occur. The reader is referred to pages 22 through 32 of this report for a detailed discussion of past air releases of DU.

2. There is concern that former Arsenal workers could have been exposed to harmful levels of beryllium and depleted Uranium.

Industrial hygiene practices at the Arsenal focused on minimizing worker exposures to these materials. (58,59,60) Consequently, the health risks associated with working with beryllium and DU were reduced. Studies among beryllium-exposed workers, within the industry as a whole, have shown the prevalence of chronic beryllium disease (CBD) to be only 5%. (61) Since there was little opportunity for workers to be exposed to beryllium at the Arsenal, their risk of developing CBD was even further reduced. With regard to depleted Uranium workers, sound industrial hygiene and health physics practices coupled with the results of a medical surveillance program do not suggest exposures occurred at levels of health concern. (59,62)

Beryllium:
Because the principal safety hazard in dealing with beryllium is inhalation, glove boxes and exhaust collection systems were in place for areas where beryllium work was carried out. (58) These industrial hygiene practices would greatly reduce possible worker exposures to the metal. Community members stated that a former Arsenal worker died of berylliosis (63,64), but details regarding the circumstances which lead to the worker's exposure and the subsequent development of disease were unavailable. (58,59,62)

There are two types of diseases associated with inhalation exposure to beryllium: acute beryllium disease and chronic beryllium disease. *Acute beryllium disease*, which is a chemical pneumonitis, can result from breathing high concentrations of soluble beryllium. However, since the implementation of the Atomic Energy Commission's 1950 recommendations calling for a 99% reduction of beryllium concentrations in the work environment, acute beryllium pneumonitis was completely eliminated. (61,65)

Chronic beryllium disease (CBD), an immunologic disease, only occurs in a small number of people who are exposed to both soluble and insoluble forms of the metal. This finding was reported in studies of industry workers who were exposed to beryllium. CBD is an immunologic lung disease, characterized by chronic hypersensitivity, for which there is no effective treatment. (66,67) Sensitized individuals develop granulomas in their lungs, which are clusters of immune cells (lymphocytes) that accumulate around beryllium particles in the alveoli of the lungs. (61) Studies suggest that there are at least two risk factors for CBD; exposure to the metal and inheritance of a genetic marker linked with susceptibility to the disease. (61,68)

It is also known that the onset of CBD may occur up to 10 to 20 years after exposure. (66,67) A blood test, the beryllium lymphocyte proliferation test (BeLT), can be done to detect early CBD or to make a specific diagnosis of CBD. If an individual has been sensitized to beryllium, their blood lymphocytes will proliferate when cultured in the laboratory in the presence of beryllium salts. (61)

Depleted Uranium:

Industrial hygiene practices at the Arsenal focused on minimizing worker exposure to DU, which could occur through inhalation, ingestion, or through skin lesions. DU is a byproduct of the nuclear industry that is less radioactive than the naturally occurring uranium. All operations involving DU complied with safety and health physics standards applicable at that time and individual radiation exposures were monitored to ensure that allowable exposure doses to workers were kept well within permissible limits. (60)

The most likely route of occupational exposure to DU is via inhalation. However, when an individual breathes in uranium dust, most of it leaves the lungs when the person coughs or breathes out. (69) Some of the more soluble compounds of DU that remain in the lung are taken into the blood stream. Once in the blood stream, the soluble DU may result in significant deposits in the kidneys, where chemical toxicity occurs. (70) However, DU is eliminated from the kidneys at a rate of about half every two weeks. Moderately severe damage to the kidney as a result of acute exposure is repairable, and a return toward normal kidney function may occur even during continued exposure. (60) Any insoluble DU compounds that are deposited in the respiratory system are mobilized slowly. Although these insoluble DU compounds pose a radiation hazard to the lungs, adverse health effects on the

respiratory system are not expected to occur because individual exposure doses at the Arsenal were well within permissible limits.

If exposure occurred via ingestion, only about 1% of the soluble uranium (U) is absorbed from the digestive system and less than 0.2% of insoluble U is absorbed into the bloodstream. (71) Depleted Uranium that enters the bloodstream would be deposited primarily in bone and the kidney, and some would be excreted in the urine. Unabsorbed compounds would be quickly eliminated from the body in the feces.

Hazards associated with handling DU metal is beta radiation exposure to eyes, hands and fingers. Thermoluminescent dosimeters were recommended for monitoring DU exposures to the extremities. Personal protective equipment, such as leather gloves, reduced exposures to the hands by 50%. (60) DU could also enter the blood stream through contaminated wounds.

In addition to implementing safety procedures designed to reduce occupational exposure, the Arsenal maintained a medical surveillance program to check workers for uptake of DU. Urine testing was done quarterly to determine the concentration of DU excreted by workers. (59,60) Urine testing, which detects soluble DU, was used as an indicator of chronic exposure.

Also, exit physicals were available to workers, which included pulmonary function tests, and kidney function tests as well as other evaluations. (59,62) Clinic medical staff remarked that there were no abnormalities in workers that might be associated with occupational exposures. (59,62) Workers were provided copies of their medical records upon request. Once an employee no longer worked at the Arsenal, that individual's records were sent to the National Personnel Records Center in St. Louis, Missouri. These records are filed by the individual's name, date of birth, social security number and the name of the agency where they had worked. (59)

3. Were any nuclear materials from the Arsenal buried in the community?

The information that we reviewed does not suggest that nuclear materials from the Arsenal were buried in the community. Disposal procedures described in the Former Watertown Arsenal Preliminary Investigation (13) indicate that <u>no radioactive or hazardous wastes</u> were discarded in Watertown landfills or the town incinerator.

Extensive investigations and environmental cleanup at the MTL facility is being conducted at this time. Much of the cleanup of residual radiological contamination from past industrial activities at that site has already been completed. Moreover, the property cannot be transferred for reuse until all necessary remedial actions, which are regulated by the Environmental Protection Agency, the Nuclear

Regulatory Commission, and the Massachusetts Departments of Environmental Protection and Public Health, are taken.

There is residual radiologic contamination on the FUDS parcel, now the Arsenal Marketplace (11,13) and the GSA site (37,51), which were both part of the original Watertown Arsenal. However, these sites do not pose a health hazard to members of the general public because access to contaminated areas is restricted. The reader is referred to sections entitled *Subsurface Contamination* (FUDS Parcel, now the Arsenal Marketplace), pages 10-18 and *GSA site - Northeast Area*, pages 22-25 for detailed discussions regarding these areas.

Other Concerns in Watertown:

4. Watertown residents believe that cancer incidence in their community is higher than expected. They are particularly concerned that multiple sources of environmental pollution in their community could be contributing to cancer occurrence.

To address concerns about multiple sources of contamination in the community, ATSDR evaluated the likelihood of people coming in contact with hazardous materials in particular areas in Watertown. These included: the Arsenal, Arsenal Park, United Parcel Service, Watertown municipal landfills, and the neighborhoods of Frank Street, North Beacon Street, Bay Street, Palmer Street and Parker Street. We consider it unlikely that residents could be exposed to hazardous levels of contaminants in any of these areas. Our conclusions are based on observations we made during tours of areas that were brought to our attention by community members, and on our review of all the applicable environmental data relating to specified waste sites in Watertown. Details regarding our evaluation of specific sites are provided in Appendix A.

People have strong fears about cancers caused by environmental exposures. Although the term "environmental" causes of human cancer includes everything other than genetic factors, it has been estimated that only about 2% of cancer deaths are attributed to environmental pollution. (72) Often, cancer cases that are linked to chemical exposure afflict individuals who were occupationally exposed to high concentrations of particular types of chemicals. Such occupational exposures appear to account for about 5% of all cancer deaths. (73) The presence of environmental contamination in a community, does not necessarily mean that people are coming into contact with sufficient quantities of hazardous materials to cause disease. Again, we emphasize that it is our opinion that people have not come into contact with contamination.

It is widely recognized that cancers, like heart disease, are very common illnesses that occur in all communities. In order to put the number of individual cancer cases in Watertown into perspective, comparisons must be made to the occurrence