UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PENNSYLVANIA 19406-1415

December 13, 1996

Dear Madam/Sir:

SUBJECT: JOINT REPORT TO THE NUCLEAR METALS INC., (NMI) SOIL SAMPLING DISCUSSION GROUP

Enclosed please find a copy of the Joint Report of the Commonwealth of Massachusetts Department of Public Health - Radiation Control Program and U.S. Nuclear Regulatory Commission Region I to the NMI Soil Sampling Discussion Group. This report is based on surface soil sampling that was conducted in the vicinity of NMI on December 3-6, 1995.

The Soil Sampling Discussion Group (Group) was formed in 1995 to further discuss the results of limited soil sampling that was conducted by NRC Region I in November 1994 and by the Citizen's Research and Environmental Watch (CREW) in April 1994. The Group recommended additional sampling in the off-site areas surrounding NMI to determine if there was surface soil deposition of depleted uranium from NMI, and to determine if there were any safety concerns. The NRC and Massachusetts Department of Health, Radiation Control Program (MDPH-RCP) conducted the sampling and analysis at their cost, but there was significant and much appreciated participation by CREW, the Massachusetts Department of Environmental Protection, the Concord Board of Health and Acton Health Department, the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, and NMI. Other members of the public and elected officials also participated, and residents and private businesses permitted sampling on their property in addition to Concord and Acton conservation lands.

As detailed in the summary of the attached report, all sample results were significantly below the NRC release criteria for unrestricted use. All of the gamma spectrometry analyses had relatively large uncertainties and detection levels that could not be distinguished from background. Since these levels are statistically indistinguishable from background levels of natural uranium, any health impact over background would be undemonstratable. Based on alpha spectroscopy, three of the six sample results appear to indicate depleted uranium (DU) with nominal values of between 1 to 2 picocuries per gram of soil. These results indicate that the concentration of depleted uranium is on the order of twice the natural uranium concentration. Depleted uranium results that are twice background or less are not considered to be statistically significant, and well below the NRC release criteria of 35 picocuries of DU per gram of soil.

In conclusion, there are no safety concerns identified for residents of Concord or Acton with respect to surface soil deposition of depleted uranium. The low concentrations of depleted uranium in the surface soil do not indicate a significant offsite radiological impact from routine operations at NMI over the past 28 years.

Questions concerning this joint report may be directed to Thomas O'Connell, Radiation Specialist, MDPH-RCP at 617-727-6214, ext. 6891, and Marie Miller, Senior Health Physicist, NRC RI at 610-337-5205.

Submitted by,

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JOINT REPORT OF THE COMMONWEATLH OF MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH-RADIATION CONTROL PROGRAM AND THE UNITED STATES NUCLEAR REGULATORY COMMISSION, REGION I

I. INTRODUCTION AND SITE HISTORY

This report documents the results of surface soil sampling that was conducted primarily within 0.5 miles of Nuclear Metals, Inc. (NMI). NMI is located at 2229 Main Street (Route 62) on a 46 acre tract in the West Concord Industrial Park of Concord, Massachusetts. Most of the surrounding area consists of wooded residential developments, a few industrial and commercial sites, and at least two wetland areas. NMI is within 0.5 miles of the Town of Acton, so the affected sampling area included both Concord and Acton properties. The local Health Departments supported the sampling program by identifying available town property and in soliciting permission to sample private property.

NMI started operations at this location in 1958. All current activities involve depleted uranium[1] metal processing, which are presently licensed under NRC License Nos. SMB-179 and SUB-1452. The Commonwealth of Massachusetts plans to become an NRC Agreement State, and it is expected that the Massachusetts Department of Public Health-Radiation Control Program (MDPH-RCP) will assume regulatory responsibility in the near future.

Sampling in offsite areas was conducted in followup to the NRC and MDPH-RCP sampling that was conducted in November 1994, and in response to the concerns from the public regarding discrepancies between offsite soil sample results reported in NRC Inspection Report 040-00672/94-001, dated April 7, 1995, and Citizens' Research and Environmental Watch (CREW) Report, released October 7, 1994 based on samples taken by CREW in April 1994.

These reports concluded that the levels of Uranium-238 were within the NRC release criteria for unrestricted use for depleted uranium, which is 35 picoCuries per gram (pCi/g). The NRC and MPDH-RCP concluded that with the limited number of samples and analytical results with large uncertainties, that it was difficult to determine if there were variations in natural background for the area or if there had been some surface deposition of Uranium-238, because of NMI operations involving depleted uranium. CREW concluded that there were elevated levels of depleted uranium in the environment, and that additional sampling was necessary to characterize the surface deposition from airborne releases from NMI.

At the May 31, 1995, public meeting hosted by the Commonwealth of Massachusetts Department of Environmental Protection (MADEP) in Concord, NRC announced that it would be willing to conduct additional soil sampling within 0.5 miles of NMI. The MDPH-RCP also agreed to conduct split sampling with the NRC. The MADEP offered to provide a forum for the discussion of technical issues relevant to soil sampling locations

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[1]Uranium consists of three primary isotopes, U-238, U-235 and U-234. Uranium depleted in U-235 and U-234 predominantly consists of U-238 and is called depleted uranium or DU.

and methodology for the next round of off-site sampling surrounding the NMI facility. Subsequently, three meetings were held by the NMI Soil Sampling Discussion Group (See Distribution List for Participants).

Soil sampling was conducted on December 3-6, 1995. Samples were split between CREW, MDPH-RCP, NMI, and NRC. MDPH-RCP and NRC results are reported jointly for comparisons. There was agreement between these two agencies with respect to the interpretation of these results.

II. PURPOSE

The purpose of this survey was to complete the following:

- Obtain sufficient offsite radiological data with respect to the surface soils;
- Determine if there is a health and safety concern from any accumulation of depleted uranium from airborne deposition in the surface soils near the NMI facility; and
- Report the results by compass sectors and inform property owners of their result.

III. SAMPLING PLAN

Although there was not a consensus of the group with respect to the sampling plan and the analysis methods, the group agreed that some sampling would be of benefit. There was consensus with respect to the sampling locations.

The following plan was presented to the Group:

(1) background soil concentration would be determined from samples collected at least 5 miles from the NMI facility. Background samples would represent sample media, i.e., clay, sandy or organic (peat moss/pine needles);

(2) soil samples would be collected generally within 2 inches in depth. At each location the sample depth, direct radiation reading, and the GeoPositioning System (GPS) coordinates would be recorded;

(3) a minimum of two samples per 8 compass sectors would be collected out to 0.5 miles. A few samples beyond 0.5 miles would be collected in the predominant downwind sectors. Most sampling locations would be town land. Whenever a private property was sampled, the location would be referred to only by compass sector and sample number. The sample locations will be shown generally on a map, and identified by compass sectors only. (See Attachment 1 for map of twenty seven sample locations);

(4) initially samples would be analyzed by NRC and MDPH-RCP using gamma spectrometry. The radionuclides of interest are uranium (U-238 and U-235) for purposes of quantifying natural uranium[2] in comparison to depleted uranium. Based on soil results, a limited

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[2]Natural uranium is naturally-occurring and consists of three primary isotopes, U-238, U-235, and U-234 with 0.72% U-235.

IV. SAMPLE ANALYSES

All NRC soil samples were air dried, milled, weighed into 250 ml Marinelli beakers, and counted on a high resolution gamma spectrometry system for 60,000 seconds to determine U-235 and U-238 concentrations. The U-235 concentration was determined from the isotope's 143 keV photopeak. The concentration of U-238 was inferred from the concentration of the Pa-234m decay progeny of U-238 (1,001 keV photopeak). MDPH-RCP followed a similar procedure using the same isotope peaks for identification.

Low sample weights were experienced for a number of the samples, because the sample contained more organic material than soil. The density of any sample less than 1 gram/cubic centimeter was considered as a mixture of soil and organic media. No tests were performed to demonstrate variability in soil types by density. Samples with densities greater than 1 gram/cubic centimeter were considered soil samples.

In order to obtain additional data to supplement the interpretation of the analytical results, seven of the NRC samples were sent to the NRC reference laboratory, Oak Ridge Institute for Science and Education (ORISE), for analysis by alpha spectrometry and for comparative gamma spectrometry. Included in this data set were samples that were representative of soil and organic samples, near the facility (< 0.25 miles), and a background sample.

V. INTERPRETATION OF RESULTS

Results are shown in Section VI, Tables 1 - 3. A detected value represents a distribution of values around the result. A value is considered detected if the result is greater than or equal to 2σ (the counting uncertainty at the 95% confidence level). For example: the result for A-1 reported at 2σ is 4.7 $\pm$ 2.8, for a distribution of values from 1.9 to 7.5. Correspondingly, the result reported for A-2 at 2σ is 2.5 $\pm$ 3, for a distribution of values from -0.5 to 5. This result is considered not detected, because the range includes zero.

As expected the alpha spectroscopy results (Table 2) have the smallest counting uncertainty and provide the basis for the conclusions in this report. However, all results were interpreted against three criteria to determine if depleted uranium could be identified.

- The first method subtracts the background uranium concentration from any detected value. Because of the differences in the sample densities, there were two background levels, one for soil samples and one for soil/organic samples based on samples collected from areas greater than 5 miles from NMI.

- The second method calculates a ratio of the radioactivity of U-238 to U-235 for any positive result. The activity (uCi/g) ratio of U-238/U-235 is approximately 22 for natural uranium and the ratio of U-238/U-235 is greater than 39 for depleted uranium.

- The third method, applied to the alpha spectroscopy results, calculates a ratio of the radioactivity of U-238 to U-234. Natural uranium has a ratio of U-238/U-234 of 1, while depleted uranium has a ratio of U-238/U-234 of 2 or greater.

VI. RESULTS

TABLE 1: NRC AND MDPH-RCP GAMMA ANALYSIS RESULTS

			NRC RESULTS		MA RESULTS	
Compass Sector	**Sample ID**	**Density (g/cc)**	**Pa-234^M (pCi/g)**	**U-235 (pCi/g)**	**Pa-234^M (pCi/g)**	**U-235 (pCi/g)**
NORTH	A-1	0.63	**4.7 ± 1.4**[1]	**0.11 ± 0.04**	**3.7 ± 0.8**	**0.09 ± 0.02**
	A-2	0.38	2.5 ± 1.5	< 0.15[2]	**3.1 ± 1.2**	**0.14 ± 0.03**
NORTH EAST	B-1	0.60	**2.6 ± 1.1**	0.08 ± 0.05	**4.1 ± 1.1**	**0.08 ± 0.03**
	B-2	0.83	**2.2 ± 0.9**	< 0.07	2.6 ± 1.3	0.04 ± 0.03
	B-2B	0.70	1 ± 2	< 0.08	1.0 ± 1.0	0.04 ± 0.03
	B-2C	0.31	< 3.6	0.17 ± 0.09	**4.7 ± 1.1**	**0.09 ± 0.03**
EAST	C-1	0.71	**3.1 ± 1.1**	0.07 ± 0.04	**3.8 ± 0.9**	**0.07 ± 0.02**
	C-2-A	1.15	**2.0 ± 0.7**	0.06 ± 0.03	1.4 ± 0.9	**0.07 ± 0.02**
	C-2-B	0.66	**3.4 ± 1.4**	< 0.08	**3.0 ± 0.9**	**0.08 ± 0.03**
	C-3-A	0.72	**2.8 ± 1.2**	< 0.08	**3.6 ± 0.1**	**0.07 ± 0.03**
	C-3-B	0.81	< 1.4	< 0.08	0.2 ± 0.9	0.00 ± 0.02
SOUTH EAST	D-1	1.53	< 0.7	**0.10 ± 0.03**	2.9 ± 1.6	**0.09 ± 0.04**
	D-2	0.85	**1.9 ± 0.9**	0.10 ± 0.05	**3.0 ± 0.7**	**0.06 ± 0.02**
SOUTH	E-2	0.23	4 ± 2	0.20 ± 0.11	**28 ± 13**	-0.06 ± 0.27
SOUTH WEST	F-1-A	1.10	**2.5 ± 0.7**	**0.12 ± 0.04**	**2.2 ± 1.0**	**0.05 ± 0.02**
	F-2	1.18	**2.5 ± 0.8**	**0.10 ± 0.03**	2.3 ± 1.2	**0.18 ± 0.06**
WEST	G-1	1.54	1.3 ± 0.7	**0.12 ± 0.03**	2.0 ± 1.3	**0.12 ± 0.04**
	G-2	1.17	**1.9 ± 0.7**	< 0.05	**3.3 ± 0.9**	**0.05 ± 0.02**
	G-2-A	1.42	0.9 ± 0.6	**0.08 ± 0.03**	1.5 ± 1.2	**0.08 ± 0.03**
N.WEST	H-2	1.11	1.0 ± 0.6	< 0.05	**3.0 ± 1.2**	**0.06 ± 0.02**
N. WEST & NORTH[3]	J-1	1.21	< 0.9	**0.10 ± 0.04**	**3.1 ± 1.2**	**0.09 ± 0.03**
	J-2	0.28	**5 ± 2**	< 0.2	**3.4 ± 1.6**	**0.11 ± 0.04**
	J-2-A	1.07	1.0 ± 0.7	**0.12 ± 0.04**	**3.1 ± 0.8**	0.04 ± 0.02
NORTH EAST[3]	K-1	1.50	**1.8 ± 0.7**	**0.12 ± 0.03**	0.8 ± 1.2	0.06 ± 0.03
	K-2	1.61	< 1.8	0.04 ± 0.03	**2.1 ± 0.7**	**0.06 ± 0.02**
S.EAST	L-1	1.38	**2.3 ± 0.7**	**0.07 ± 0.03**	**2.2 ± 1.0**	0.04 ± 0.02
SOUTH	VEG	0.24	3 ± 2	< 0.2	0.8 ± 4.4	0.16 ± 0.12

NOTES

1. Results considered detected are shown in bold to contrast non-detected or less than the lower limit of detection. An uncertainty of one standard deviation (1σ) is reported based on counting statistics alone. Negative and other results less than or equal to 2σ are interpreted as including "zero" or as not detected. The laboratory estimates the systematic error for these samples at 15 %.
2. When no value if reported, this means that the activity was less than the lower limit of detection (LLD) for that sample size, count time, and for the specific gamma spectrometry system.
3. Samples IDs "J and K" were collected from Concord and Acton town lands at least 5 miles away from NMI to be representative of natural background for the area.

TABLE 2: ORISE ALPHA SPECTROMETRY RESULTS

SAMPLE ID & SECTOR	URANIUM CONCENTRATIONS (pCi/g)			
	U-238	U-235	U-234	Total Uranium[a]
A-1 North	2.41 ± 0.30[b]	0.12 ± 0.06	1.23 ± 0.20	3.76 ±0.37
B-2C N.East	1.04 ± 0.18	0.07 ± 0.06	0.95 ± 0.18	2.07 ± 0.26
C-1 East	2.11 ± 0.27	0.07 ± 0.05	0.80 ± 0.16	2.98 ± 0.32
C-2B East	0.97 ± 0.17	< 0.06	0.83 ± 0.16	1.83 ± 0.24
E-2 South	1.16 ± 0.19	< 0.10	0.28 ± 0.11	1.45 ± 0.23
G-2 West	1.04 ± 0.18	0.05 ± 0.04	0.72 ± 0.15	1.82 ± 0.23
J-2 North	0.25 ± 0.08	<0.07	0.23 ± 0.09	0.48 ± 0.12

NOTES

a. Total uranium concentrations are calculated based on the sum of the U-234, U-235 and U-238 concentrations.
b. Uncertainties represent the 95% (2σ) confidence level, based only on counting statistics.

TABLE 3: COMPARISON OF URANIUM-238 RESULTS

SAMPLE ID & SECTOR	URANIUM CONCENTRATIONS (pCi/g)[1]			
	ORISE (alpha)	MDPH-RCP	ORISE (gamma)	NRC
A-1 North	2.41 ±0.15	3.7 ± 0.8	3.3 ± 0.5	4.7 ± 1.4
B-2-C N.East	1.04 ± 0.09	4.7 ± 1.1	1.9 ± 0.6	< 3.6
C-1 East	2.11 ± 0.14	3.8 ± 0.9	2.2 ± 0.3	3.1 ± 1.1
C-2-B East	0.97 ± 0.09	3.0 ± 0.9	0.6 ± 0.5	3.4 ± 1.4
E-2 South	1.16 ± 0.10	28 ± 13	1.0 ± 1.0	4 ± 2
G-2 West	1.04 ± 0.09	3.3 ± 0.9	2.3 ± 0.4	1.9 ± 0.7
J-2 North [2]	0.25 ± 0.04	3.4 ± 1.6	< 2.3	5 ± 2

NOTES

1. An uncertainty of one standard deviation (1σ) is reported based on counting statistics alone. Small negative and other results less than or equal to 2σ are interpreted as including "zero" or as not detected. The laboratory estimates the systematic error for these samples at 15 %. When no value if reported, this means that the activity was less than the lower limit of detection (LLD) for that sample size, count time, and for the gamma spectrometry system or for the ORISE alpha spectrometry system.

2. Sample J-2 was an organic/soil sample, collected at least 5 miles away from NMI to be representative of natural background for the area.

VI. CONCLUSIONS

The NRC Branch Technical Position "Disposal or On-site Storage of Residual Thorium or Uranium for Past Operations" (46 FR 52061-63) ("BTP") describes the maximum concentrations of uranium and/or thorium for a range of disposal options. The most restrictive concentration for depleted uranium is 35 pCi of total uranium per gram. A property with a total depleted uranium concentration less than this value may be used without restriction.

All samples results were well below the BTP concentration of 35 pCi of total uranium per gram of sample media. Although the gamma spectrometry analysis had relatively large uncertainties, and detection levels could not be distinguished from the background results, 15 of the 27 samples had positive results (detected values) for both the U-238 and U-235. The U-238/U-235 ratios for the 15 samples indicated natural uranium when applying the U-238/U-235 ratio criteria.

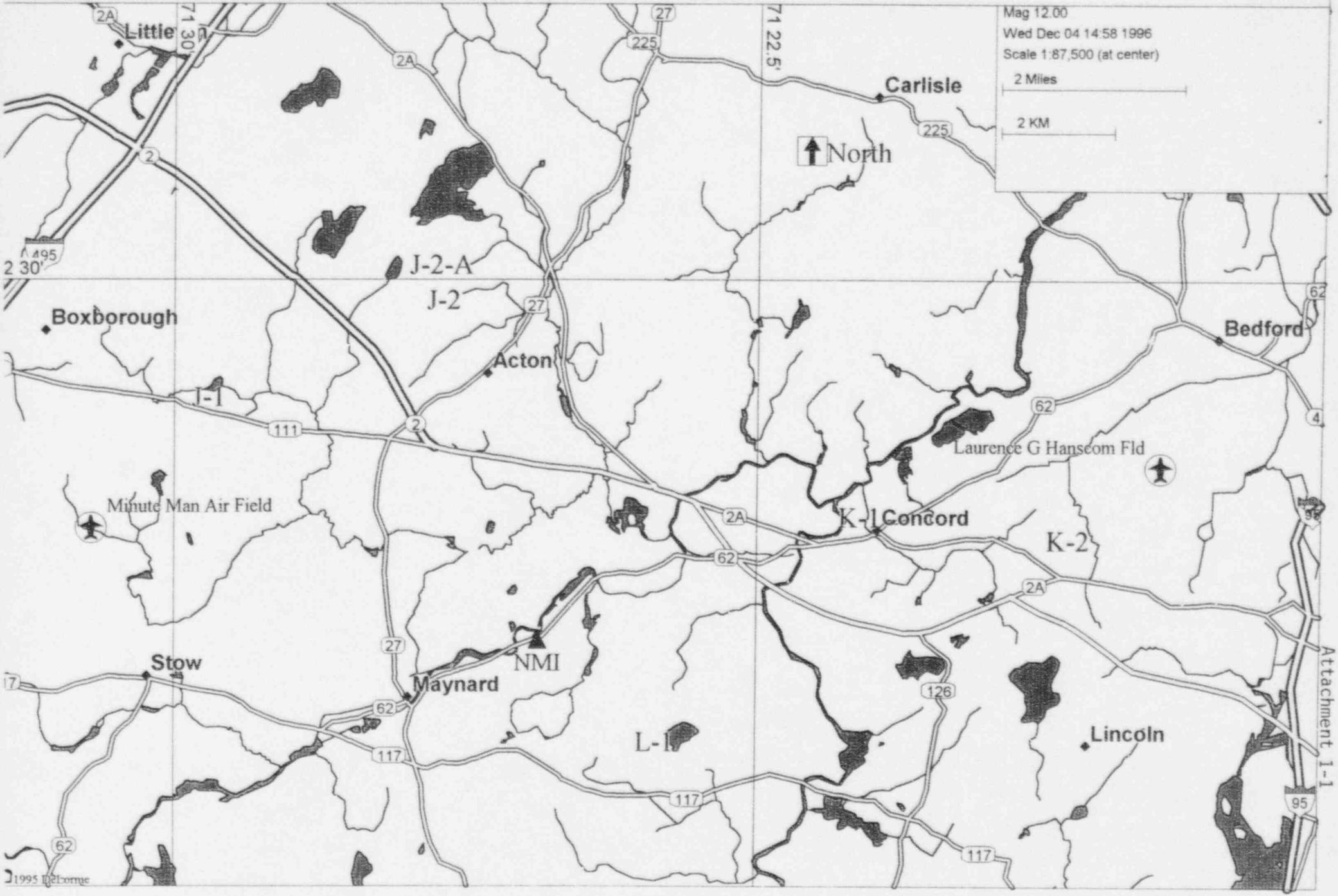
The seven alpha spectrometry analyses (six sample locations and one background location) identified depleted uranium in three samples. Samples A-1, C-1 and E-2, which were from samples located close to the facility boundaries (i.e., $<1/4$ mile), have U-238/U-234 ratios on the order of 2, indicating depleted uranium. The total uranium identified in these samples ranged from 1.45 to 3.76 pCi/g (see Table 2). The background contribution from these samples could not be subtracted, because the soil/organic background sample (J-2) had undetected U-235. Also, a background soil sample was not submitted for alpha analysis.

The evaluation of the other three samples indicated positive results with U-238/U-234 ratios of 1. With a ratio match to natural uranium, these three samples are representative of background from natural uranium. Therefore, the background for total uranium ranges from 0.5 to 2 pCi/gram of soil, based on alpha spectrometry.

Table 3 compares the U-238 concentrations determined by ORISE alpha spectrometry to the gamma spectrometry results reported by MDPH-RCP, ORISE and NRC. This comparison illustrates that gamma spectrometry can accurately quantify U-238 concentration, which would require remediation to meet unrestricted release criteria. Yet the sample uncertainty for identifying U-238 of natural background concentrations is large. In contrast, alpha spectrometry better distinguishes residual contamination from naturally occurring uranium, because of the smaller sample uncertainty.

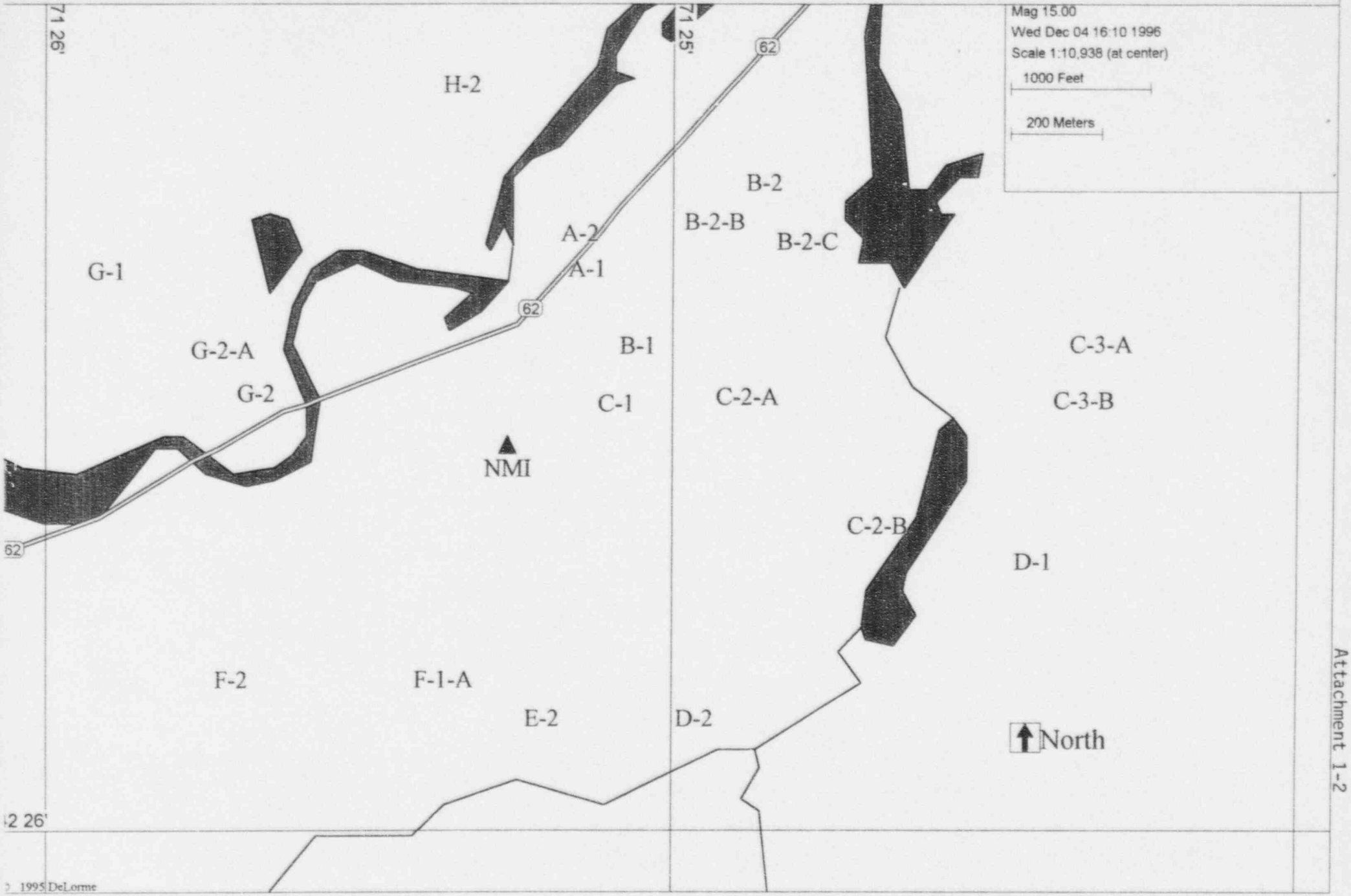
In conclusion, because of the large uncertainties that accompany the gamma spectrometry analytical method for U-238, all twenty seven results are determined to be indistinguishable from natural background. All results are well below the NRC release criteria for unrestricted use. The three alpha spectrometry results that identified depleted uranium were also below the NRC release criteria for unrestricted use, by at least a factor of 10. Further the levels of depleted uranium identified were not greater than twice the background levels of natural uranium in the environment. At these concentrations, there is no statistical significance, and therefore, no health and safety concerns relative to deposition of depleted uranium in surface soils near the NMI facility.

NMI Soil Sampling map 1



Attachment 1-1

NMI Soil Sampling map 2



Attachment 1-2