*Data Analysis of the 1984 and 1986
Soil Sampling Programs
at Materials Disposal Area T
in the Los Alamos National Laboratory*

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LOS ALAMOS NATIONAL LABORATORY**

by

John W. Nyhan and Barry J. Drennon

ABSTRACT

An environmental surveillance program for Materials Disposal Area T (MDA-T) at Los Alamos, New Mexico is described. The waste-use history of this disposal site is described, followed by a description of the materials and methods used to analyze data from two surface soil radionuclide sampling programs performed at this disposal site. The disposal site's physical features are related to the spatial distribution of radionuclide concentration contours in an attempt to evaluate radionuclide migration mechanisms in and around the site. The usefulness of the data analysis efforts is evaluated and recommendations are made for future studies.

I. INTRODUCTION

In the late 1970s the Department of Energy (DOE) issued interim operational criteria for radioactive waste areas owned or operated by DOE and its contractors (1-3). As a first response to the surveillance requirements listed in these criteria, personnel from the Environmental Surveillance Group at the Los Alamos Scientific Laboratory (LASL) developed an interim surveillance plan for the site's radioactive waste areas (4). More specifically, the stated objectives of this plan were to:

"(1) provide information to evaluate whether radioactive waste sites at LASL are being managed and maintained in an environmentally acceptable manner; and whether applicable criteria, such as the DOE Interim Criteria for Waste Management are met;

(2) identify and document possible changes over time for each area;

(3) provide data for the Annual Environmental Surveillance Report; and

(4) provide other environmental documentation that might be required prior to changes or additions to activities at LASL."

The original plan (4) called for a brief annual survey of each waste site starting at the end of FY-1981, involving portable radiation detector surveys and sampling programs for soils, vegetation, air, and small mammals. An additional detailed survey was to be performed on each waste area at least once every five years, with two or three waste areas being subject to this type of survey within any given year. The detailed surveys were meant to encompass more sampling locations, techniques with lower detection limits, and extensive sampling of surface soils (three depths in the top 30 cm of soil) and subsurface soils (depths below 30 cm).

Concurrent with the initial annual survey at each waste disposal area, a sampling grid was to be established by civil engineering surveys (4). The grid origin was to be randomly chosen to mitigate against bias in placement of grid points across the grid. Key points, coordinate axes

and perimeters were to be installed to assure adequate accuracy. An emphasis was placed on relating the sampling grids to the local Los Alamos Scientific Laboratory coordinate system.

A recent summary of this routine monitoring and special study research data at MDA-T was published (5), which described data collected from 1946 through 1986 (see Appendix A-3). This summary suggests that only two detailed surface soil surveys of this disposal site had the potential of yielding useful information for documenting site surveillance activities for the current DOE Environmental Restoration Program activities. These two surveys were both performed as part of the original DOE program described earlier (4). Soil samples for these two surveys were collected in June 1984 and from June through July 1986. Although the results of the 1984 survey were never summarized in a report, the 1986 survey is well documented (5).

The objectives of this study were (1) to document the sampling locations, sampling methods, and analytical methods used in the 1984 and 1986 surveys at MDA-T and (2) to perform data analysis on the results of the radionuclide assays performed on the soil samples collected. The results of this documentation and data analysis will be used to design a soil sampling program at this disposal as part of the activities of the Environmental Restoration program.

II. DISPOSAL SITE DESCRIPTION AND WASTE USE HISTORY

MDA-T is within Technical Area 21 of the Los Alamos National Laboratory (Fig. 1) and can be reached from the north perimeter road. This disposal site is less than a quarter mile from the intersection of the north perimeter road and DP Road (6). Most of the area is found within LASL coordinates N.87 + 50 and N.90 + 00, and E.157 + 50 and E.160 + 00, with an approximate total acreage of 0.88. MDA-T is physically located east of Buildings TA-21-286 and TA-21-288 and west of Building TA-21-257.

Three different disposal modes were used at MDA-T (6). The absorption beds are the oldest used for the disposal of liquid wastes at Los Alamos (Fig. 2) and have been described in detail (6). After the construction of the 1.2-m deep, 36.6-m by 6.1-m absorption beds was completed in 1945, they received untreated radioactive liquid wastes from 1945 through 1951 from DP Site. The DP West liquid waste treatment plant was installed in

1952, largely because the volume of liquids discharged to the beds exceeded the holding capacity of the absorption beds, despite the fact that the beds were equipped with a distribution box, located between beds 1 and 2, which ensured that approximately equal volumes of wastes were discharged to these two beds. About 89% of the 69 260 m³ of liquid effluents added to the MDA-T absorption beds were added between 1945 and 1960, with the remaining 11% added in rapidly decreasing amounts until 1967. A new treatment plant was built in 1967, which also infrequently discharged treated wastes into the absorption beds. However, almost all of these treated effluents were discharged to the canyon north of the plant.

Both the addition rate and the type of waste added to the absorption beds changed with time at MDA-T. About 98% of the estimated 10 Ci of Pu discharged to the absorption beds was added as untreated wastes between 1945 and 1952 (6, 7). The concentration of Pu in the estimated 53 000 m³ of untreated effluents during this period was estimated at about 27 pCi Pu/ml, with an average fluoride concentration associated with the wastes of 160 ppm. However, about 40 m³ of untreated effluents containing large concentrations of ammonium citrate were released into the beds from June 1951 to July 1952, and these wastes contained about 6300 pCi Pu/ml and 200 ppm fluoride. The smallest contributions to the beds came between 1953 and 1967 when about 16 000 m³ of treated effluents containing only about 0.09 pCi Pu/ml were discharged to the absorption beds. As of January 1973, the absorption beds contained 4 Ci of tritium and about 10 Ci of ²³⁹Pu, generally consisting of approximately 94% ²³⁹Pu and 6% ²⁴⁰Pu by weight.

Forty-nine 8-ft diameter disposal shafts (on 12-ft centers) and thirteen 6-ft diameter disposal shafts were augered with a bucket auger, principally between Absorption Beds 2 and 4 (Figures 3 and 4). These shafts were augered to depths of 15 to 68 ft between 1970 and 1976 (6). The wastes going to the shafts, which were lined with asphalt, were mixed with cement and pumped down the shafts. As of July 1976, these 62 disposal shafts contained approximately 47 Ci of ²³⁸Pu, 191 Ci of ²³⁹Pu, 3761 Ci of ²⁴¹Am, 7 Ci of ²³³U, and 3 Ci of mixed fission products (6).

The third disposal mode at MDA-T consisted of waste disposal in 20 ft-long corrugated metal pipes (CMPs) with a diameter of 30 inches within the Retrievable Waste Storage Area (primarily located between Absorption Beds 1 and 3; see Figures 5 and 6). Treated wastes from TA-21-257 were mixed with cement and pumped into the

Fig. 1. Location of technical areas and materials disposal areas at Los Alamos National Laboratory

CMPs. Sixty-nine of these CMPs contained low-level radioactive wastes with a total inventory (8) of 0.77 Ci (0.044 g) ^{238}Pu , 1.18 Ci (19.2 g) ^{239}Pu , 15.3 Ci (4.7 g) ^{241}Am , and 0.16 Ci of mixed fission products. All 69 CMPs were relocated to MDA-G in 1984. An additional 158 CMPs contained transuranic wastes with a total inventory (8) of 30.97 Ci (1.8 g) ^{238}Pu , 59.4 Ci (966.9 g) ^{239}Pu , 10385.4 Ci (3205.4 g) ^{241}Am , and 0.4 Ci of mixed fission products. These 158 CMPs were relocated to MDA-G in 1986.

III. MATERIALS AND METHODS

A. Soil Sampling, Surveying, and Radionuclide Assay Techniques

Soil sampling techniques were initially outlined in the interim environmental surveillance plan for this ongoing DOE program (4). The details of how the samples were actually collected and processed for radiochemical analysis were never fully documented. This information will be presented here as the result of interviewing

Fig. 2. Aerial photograph of four absorption beds at Area T in 1965.

personnel of the Environmental Surveillance Group who actually collected the samples since the initiation of this program in 1979.

Through 1985, approximately 500 to 900 g of soil were sampled from each of the 0-1, 1-10 cm, and 10-30 cm layers of the soil profile at each sampling location. The original concept was to attempt to collect samples of approximately the same weight from each sampling depth. Thus, a steel cylinder (9) with an inside diameter of 30 cm and a height of 1 cm was used in collecting samplings from the 0-1 cm depth. After this sample was removed, a steel cylinder (9) with an inside diameter of 7.5 cm and a height of 9 cm was placed in the center of the previous excavation and driven into the profile to collect the 1-10 cm sample. The final 10-30 cm sample was collected in the same hole by driving a metal scoop with an inside diameter of 7.5 cm to the final 30 cm depth. In 1986, surface soil samples were collected to a depth of

5 cm using a coring tool with a 7.5 cm inside diameter (5). Unlike all of the samples collected before 1986 (where the entire soil sample was analyzed), these samples were sieved through a 50 micron mesh screen and only the fine fraction was analyzed for radionuclides.

The sampling locations were surveyed using different grid systems with time, as will be discussed in more detail later in this report. The intensive surveys performed through 1985 were based on the 1980 survey of MDA-A. This survey established sampling locations on 20 m centers for an area located as far west as MDA-T and as far east as MDA-U. The origin of this coordinate system was located near the southwestern gate to MDA-A. This origin was found to have New Mexico State Plane (NMSP) coordinates (feet) of 492997.24, 1774123.06 (10). The Y-axis of this coordinate system consisted of a N.60°29'33" E. line which formed a 42° angle with the easting lines of the LASL coordinate system. Sampling

Fig. 3. Bucket auger being used to drill disposal shafts between Absorption Beds 2 and 4 at MDA-T. Absorption Beds 1 and 3 are behind the drill rig and represent the low areas to each side of the drill rig.

locations were marked with flagged spikes flush with the ground surface by the Laboratory's surveyors (10).

In 1986 Environmental Science Group personnel laid out a grid of sampling locations across MDA-T on 10 m centers (5). This coordinate system was laid out with respect to two reference points, which were surveyed in February 1990 (Engineering Drawing ENG-21-61, February 15, 1990). The two reference points were: (1) a point near the northwest corner of Building DP-257, and (2) a point near a sewer manhole, identified in Engineering Drawing ENG-21-61 as sample points CA-1 and CA-2, respectively. More details about this grid system will be presented in the Results and Discussion section of this report.

The radiochemical procedures for processing the soil samples through 1985 are summarized in Los Alamos National Laboratory report LA-8810-ENG (11). The analogous procedures for the assays on the 1986 samples

are described in Los Alamos National Laboratory report LA-10992-ENV (12). Plutonium is chemically isolated from a 10-g aliquot of soil, electrodeposited and counted on an alpha spectrometer. Notice that the ^{239}Pu values mentioned in this report actually represent the sum of ^{239}Pu and ^{240}Pu , because both have identical alpha energies.

B. Conversions to New Mexico State Plane Coordinate System

Microcomputer programs were developed to convert all field location values to one common rectangular grid system, the NMSP coordinate system.

One program allowed us to take LASI coordinates and adjacent brass cap data to calculate NMSP coordinates. This program was used to calculate the NMSP coordinates for the absorption beds and disposal shafts at

Fig. 4. Bucket auger (4-foot diameter) being used to ream a disposal shaft to a larger diameter at MDA-T.

MDA-T, using data for brass caps 503 and 753. The LASL coordinates for the four adsorption beds are given in Engineering Drawing ENG-C-2217 (June 13, 1945). The LASL coordinates for the disposal shafts were also estimated from this drawing.

C. Contouring Programs

Two programs were developed for use on a VAX to contour elevation and radionuclide concentration data for MDA-T.

The first program was developed using Version 11 of CA-DISSPLAY to use two-foot elevation data from the MOSS GIS system maintained by the Laboratory's Engineering Division. This program produces elevation contours across MDA-T from a data base of over 3600 observations of NMSP eastings and northings, with associated elevation values.

The second program produces contours of radionuclide concentrations in surface soils in seven

different concentration intervals. A map of these seven contours is produced using Version 11 of CA-DISSPLAY with the soil radionuclide data from each sampling grid location as the input. This program takes the 600 by 600 ft field area encompassing MDA-T and creates a matrix across this area in an attempt to generate regularly-spaced data values from a small number of data points. This matrix was either 16 by 16 regularly-spaced intervals for the 1984 soil data base (with 31 sampling locations) or 26 by 26 regularly-spaced intervals for the 1986 soil data base (with 71 sampling locations). The final surface of radionuclide contours (z values) was defined using a CA-DISSPLAY algorithm named MDFMAT. This function was used to search a total of three cells in the x (easting values) direction and three cells in the Y (northing values) direction with a weighting factor of 2.0; this calculation was performed for each point on the original matrix.

Neg #PA0830JRK162

Fig. 5. Southwest-facing aerial photograph of MDA-T taken in 1983 showing the Retrievable Waste Storage Area which contained the corrugated metal pipes.

Neg #PA083038K163

Fig. 6. West-facing aerial photograph of MDA-T taken in 1983 showing the Retrievable Waste Storage Area which contained the corrugated metal pipes.

IV. RESULTS AND DISCUSSION

The locations of important waste site physical features (such as fence lines, absorption beds and disposal shafts) and sampling grids will be presented first in this section, because this data was needed before an analysis of the soil radionuclide data could be accomplished. The final subsection includes an analysis of the soil radionuclide data using a series of concentration contour plots.

A. Survey results for waste site physical features and soil sampling grids

Using the two computer programs described previously, NMSP coordinates were calculated for the four absorption beds at MDA-T (Table 1), as well as for the two types of disposal shafts (Table 2). This data is presented in Figure 7, which also shows the old runway to the area occupied by the CMPs, as well as the fence around the disposal area.

Table 1. Survey information for absorption beds at MDA-T.

Absorption Bed Number	Corner of Bed	Northing/Easting Values*	
		LASL Grid System	New Mexico State Plane System
1	NW	89+31.25	1774510.94
		157+48.44	492368.34
	SW	89+14.38	1774494.57
		157+37.50	492356.67
	NE	88+52.81	1774427.45
2	SE	158+65.00	492481.34
		88+36.25	1774411.38
	NW	158+54.06	492469.68
		88+47.50	1774421.84
	SW	158+71.91	492488.01
3	SW	88+30.94	1774405.78
		158+60.97	492476.35
	NE	87+65.63	1774334.66
		159+94.38	492606.76
	SE	87+48.75	1774318.28
4	SE	159+83.44	492595.08
		89+97.50	1774575.15
	NW	157+93.44	492416.21
		89+60.63	1774538.79
	SW	157+82.50	492403.66
5	NE	89+37.50	1774510.98
		158+89.38	492509.42
	SE	89+00.94	1774474.94
		158+78.44	492496.88
	NW	89+13.13	1774485.37
6	SW	159+18.16	492537.10
		88+96.25	1774469.90
	NE	158+86.59	492504.82
		88+25.63	1774392.25
	SE	160+47.81	492662.77
7	SE	88+08.75	1774375.88
		160+36.56	492650.79

* Survey data estimated from Engineering Drawing ENG-C-2217 and data from Brass Caps 503 and 753 (entered in that order in the computer program).

Table 2. Survey information for disposal shafts at MDA-T (estimated from Engineering Drawing ENG-C-2217 and data from Brass Caps 503 and 753).

Disposal Shaft Number	New Mexico State Plane Survey Data (Easting, Northing)
<u>8-ft diam Disposal Shafts</u>	
1	492642.30,1774367.50
2	492635.30,1774357.80
3	492627.99,1774.48.11
5	492611.12,1774345.73
6	492618.30,1774355.42
8	492632.61,1774374.81
9	492622.89,1774381.50
10	492615.91,1774372.10
11	492608.61,1774362.73
13	492591.74,1774360.35
17	492603.52,1774396.11
18	492596.52,1774386.41
19	492589.21,1774376.72
20	492582.03,1774367.03
21	492572.34,1774374.33
22	492579.52,1774384.03
23	492586.84,1774393.71
24	492593.83,1774403.42
25	492584.13,1774410.41
26	492577.13,1774400.71
27	492569.82,1774391.02
28	492562.64,1774381.33
29	192552.95,1774388.64
30	492560.13,1774398.33
31	492567.45,1774408.02
32	492574.44,1774417.72
33	492564.74,1774424.72
34	492557.74,1774415.01
35	492550.43,1774405.33
36	492543.25,1774395.63
41	492545.35,1774439.02
42	492538.35,1774429.32
43	492531.04,1774419.63
44	492523.86,1774409.94
46	492521.35,1774426.94
47	492528.67,1774436.62
48	492535.66,1774446.33
49	492525.96,1774453.33
50	492518.97,1774443.63
51	492511.65,1774433.94
52	492501.94,1774440.62
53	492509.25,1774450.31
54	492516.24,1774460.01
55	492506.56,1774467.32
56	492499.56,1774457.61
57	492492.25,1774447.93
58	492482.56,1774455.24
59	492489.87,1774464.93
60	492496.87,1774474.63

Table 2. Survey information for disposal shafts at MDA-T (estimated from Engineering Drawing ENG-C-2217 and data from Brass Caps 503 and 753). (Cont.)

Disposal Shaft Number	New Mexico State Plane Survey Data (Easting, Northing)
<u>6-ft diam Disposal Shafts</u>	
70	492590.85,1774367.89
75	492581.16,1774375.20
76	492571.46,1774382.19
78	492585.93,1774401.57
80	492569.24,1774399.18
82	492552.07,1774396.50
83	492559.54,1774406.18
84	492566.54,1774415.88
87	492542.37,1774403.49
91	492537.45,1774437.18
92	492530.45,1774427.48
94	492520.76,1774434.79
95	492527.76,1774444.49
98	492501.37,1774449.06

The calculated NMSP coordinates for the 1984 survey of MDA-T are presented in Table 3. The unpublished original sample grid coordinates are presented for each soil sample collected at each sample location. The sample identification number assigned to each soil sample which underwent radionuclide analysis by the Laboratory's Health and Environmental Chemistry Group is listed in the last column in this table.

The original two reference points for the 1986 sampling grid were surveyed in 1990 (see discussion in Materials and Methods section) and an origin for the grid was derived, all in NMSP units (Table 4). The sampling grid was reconstructed from these original reference points (Fig. 8), but it incorrectly portrayed where the samples were actually collected (5). We discovered that both the origin and the other two reference points had to be adjusted as shown in Table 4 to get the sample grid locations to appear in their correct positions (5), as shown in Figure 9. Based on these adjusted NMSP coordinates for each sampling location, we then were able to reconstruct information for the 1986 survey (Table 5). All further references to the 1986 survey in this report will use the NMSP coordinates listed in Table 5 and shown in Figure 9.

Two-foot elevation contours data were collected from a 1986 elevation survey of the Laboratory, accessed through the Laboratory's Engineering Division (MOSS system). This elevation information is presented in conjunction with the 30 sampling locations in the 1984 survey (Fig. 10) and with the 71 sampling locations in the 1986 survey (Fig. 11). These two figures show that the southeastern portion of MDA-T has an elevation of about 7144 ft, proceeding to an elevation of 7130 ft close to the northwestern fence boundary. It is important to notice that the sample locations for both surveys were all collected above an elevation of about 7100 ft. As both Figures 10 and 11 show, the severe drop-off into DP Canyon starts at about 7100 ft to an elevation of about 7060 ft to the northwest. Elevations of about 7050 ft and lower are more typical of the regional bottom of this major canyon system.

Two other major elevation features should be noticed (Figs. 10 and 11). A large mound of excavated tuff was placed over the southern absorption beds, just south of the 7140 ft contour line, and extended to a total elevation of about 7160 ft. This tuff was excavated from the CMP runway area (see Figs. 5 and 6), which exhibited a major depression between absorption beds 1 and 3 to a minimum elevation of about 7122 ft.

Fig. 7. Locations of adsorption beds, disposal shafts, fence and old CMP runway in NMSP coordinate units at Materials Disposal Area T.

Table 3. Sampling grid coordinates, New Mexico State Plane coordinates and radionuclide sample numbers for the 1984 survey of MDA-T.

Sample Grid System		NMSP System		Sample Number
Easting	Northing	Easting	Northing	
-60.00	-20.00	492843.18	1774262.06	84.04146
-160.00	-40.00	492624.47	1774515.26	84.04147
-120.00	-40.00	492689.11	1774401.05	84.04148
-100.00	-40.00	492721.43	1774343.95	84.04149
-60.00	-40.00	492786.07	1774229.74	84.04150
-160.00	-60.00	492567.37	1774482.94	84.04151
-140.00	-60.00	492599.69	1774425.84	84.04152
-120.00	-60.00	492632.01	1774368.73	84.04153
-100.00	-60.00	492664.33	1774311.63	84.04154
-200.00	-80.00	492445.62	1774564.84	84.04155
-180.00	-80.00	492477.94	1774507.73	84.04156
-160.00	-80.00	492510.26	1774450.63	84.04157
-140.00	-80.00	492542.58	1774393.52	84.04158
-100.00	-80.00	492607.22	1774279.31	84.04159
-80.00	-80.00	492639.54	1774222.20	84.04160
-100.00	-100.00	492550.12	1774246.99	84.04161
-60.00	-100.00	492614.76	1774132.78	84.04162
-120.00	-10.00	492774.77	1774449.53	84.04175
-80.00	-20.00	492810.86	1774319.16	84.04176
-60.00	-20.00	492843.18	1774262.06	84.04177
-160.00	-40.00	492624.47	1774515.26	84.04178
-120.00	-40.00	492689.11	1774401.05	84.04179
-100.00	-40.00	492721.43	1774343.95	84.04180
-60.00	-40.00	492786.07	1774229.74	84.04181
-160.00	-60.00	492567.37	1774482.94	84.04182
-140.00	-60.00	492599.69	1774425.84	84.04183
-120.00	-60.00	492632.01	1774368.73	84.04184
-100.00	-60.00	492664.33	1774311.63	84.04185
-200.00	-80.00	492445.62	1774564.84	84.04186
-180.00	-80.00	492477.94	1774507.73	84.04187
-160.00	-80.00	492510.26	1774450.63	84.04188
-140.00	-80.00	492542.58	1774393.52	84.04189
-100.00	-80.00	492607.22	1774279.31	84.04190
-80.00	-80.00	492639.54	1774222.20	84.04191
-60.00	-100.00	492614.76	1774132.78	84.04192
-80.00	-20.00	492810.86	1774319.16	84.04206
-60.00	-20.00	492843.18	1774262.06	84.04207
-160.00	-40.00	492624.47	1774515.26	84.04208
-120.00	-40.00	492689.11	1774401.05	84.04209
-100.00	-40.00	492721.43	1774343.95	84.04210
-60.00	-40.00	492786.07	1774229.74	84.04211
-160.00	-60.00	492567.37	1774482.94	84.04212
-140.00	-60.00	492599.69	1774425.84	84.04213
-120.00	-60.00	492632.01	1774368.73	84.04214
-100.00	-60.00	492664.33	1774311.63	84.04215
-200.00	-80.00	492445.62	1774364.84	84.04216
-180.00	-80.00	492477.94	1774507.73	84.04217
-140.00	-80.00	492542.58	1774393.52	84.04218
-100.00	-80.00	492607.22	1774279.31	84.04219

Table 3. Sampling grid coordinates, New Mexico State Plane coordinates and radionuclide sample numbers for the 1984 survey of MDA-T. (Con't.)

Sample Grid System		NMSP System		Sample Number
Easting	Northing	Easting	Northing	
-180.00	-40.00	492592.15	1774572.37	84.04284
-200.00	-40.00	492559.84	1774629.47	84.04285
-40.00	-60.00	492761.29	1774140.31	84.04286
-60.00	-80.00	492671.86	1774165.10	84.04287
-220.00	-80.00	492413.31	1774621.94	84.04288
-240.00	-80.00	492380.99	1774679.05	84.04289
-100.00	-20.00	492778.54	1774376.27	84.04290
-80.00	-100.00	492582.44	1774189.88	84.04291
-120.00	-100.00	492517.80	1774304.10	84.04292
-140.00	-100.00	492485.48	1774361.20	84.04293
-160.00	-100.00	492453.16	1774418.31	84.04294
-180.00	-100.00	492420.84	1774475.41	84.04295
-200.00	-100.00	492388.52	1774532.52	84.04296
-220.00	-100.00	492356.20	1774589.62	84.04297
-40.00	-40.00	492818.39	1774172.63	84.04303
-200.00	-40.00	492559.84	1774629.47	84.04305
-40.00	-60.00	492761.29	1774140.31	84.04306
-60.00	-80.00	492671.86	1774165.10	84.04307
-220.00	-80.00	492413.31	1774621.94	84.04308
-240.00	-80.00	492380.99	1774679.05	84.04309
-100.00	-20.00	492778.54	1774376.27	84.04310
-80.00	-100.00	492582.44	1774189.88	84.04311
-120.00	-100.00	492517.80	1774304.10	84.04312
-140.00	-100.00	492485.48	1774361.20	84.04313
-160.00	-100.00	492453.16	1774418.31	84.04314
-180.00	-100.00	492420.84	1774475.41	84.04315
-200.00	-100.00	492388.52	1774532.52	84.04316
-220.00	-100.00	492356.20	1774589.62	84.04317
-40.00	-40.00	492818.39	1774172.62	84.04323
-40.00	-180.00	492418.65	1773946.40	84.04324
-200.00	-40.00	492559.84	1774629.47	84.04325
-40.00	-60.00	492761.29	1774140.31	84.04326
-60.00	-80.00	492671.86	1774165.10	84.04327
-220.00	-80.00	492413.31	1774621.94	84.04328
-240.00	-80.00	492380.99	1774679.05	84.04329
-100.00	-20.00	492778.54	1774376.27	84.04330
-80.00	-100.00	492582.44	1774189.88	84.04331
-120.00	-100.00	492517.80	1774304.10	84.04332
-140.00	-100.00	492485.48	1774361.20	84.04333
-160.00	-100.00	492453.16	1774418.31	84.04334
-180.00	-100.00	492420.84	1774475.41	84.04335
-200.00	-100.00	492388.52	1774532.52	84.04336
-220.00	-100.00	492356.20	1774589.62	84.04337

Table 4. Original and adjusted reference points for 1986 survey of MDA-T.

Sample grid system (Easting, northing)	Easting	NMSP Coordinates Northing
<u>Original survey reference points:</u>		
0,0	492815.76	1774166.10
-70,10	492607.15	1774253.84
-40,30	492715.08	1774295.63
<u>Adjusted survey reference points:</u>		
0,0	492825.76	1774156.10
-70,10	492607.15	1774227.34
-40,30	492725.08	1774285.63

Fig. 8. Projected sample locations for 1986 survey of Materials Disposal Area T based on original survey reference points (Table 4).

Fig. 9. Estimated locations for 1986 survey of Materials Disposal Area T based on adjusted survey reference points (Table 4).

Table 5. Sampling grid coordinates, New Mexico State Plane adjusted coordinates and radionuclide sample numbers for the 1986 surveys of MDA-T.

Sample Grid System		NMSP System		Sample Number
Easting	Northing	Easting	Northing	
-50.00	50.00	492701.44	1774351.97	86.11867
-60.00	50.00	492669.42	1774359.12	86.11868
-70.00	50.00	492637.40	1774366.28	86.11869
-70.00	60.00	492644.56	1774398.30	86.11870
-80.00	60.00	492612.54	1774405.45	86.11871
-90.00	60.00	492580.52	1774412.61	86.11872
-100.00	60.00	492548.50	1774419.76	86.11873
-110.00	60.00	492516.48	1774426.92	86.11874
-120.00	60.00	492484.46	1774434.07	86.11875
-130.00	60.00	492452.45	1774441.23	86.11876
-140.00	60.00	492420.43	1774448.38	86.11877
-80.00	70.00	492619.69	1774437.47	86.11878
-90.00	70.00	492587.68	1774444.63	86.11879
-100.00	70.00	492555.66	1774451.78	86.11880
-110.00	70.00	492523.64	1774458.93	86.11881
-120.00	70.00	492491.62	1774466.09	86.11882
-130.00	70.00	492459.60	1774473.24	86.11883
-140.00	70.00	492427.58	1774480.40	86.11884
-150.00	70.00	492395.56	1774487.55	86.11885
-100.00	80.00	492562.81	1774483.80	86.11886
-110.00	80.00	492530.79	1774490.95	86.11887
-120.00	80.00	492498.77	1774498.11	86.11888
-130.00	80.00	492466.76	1774505.26	86.11889
-140.00	80.00	492434.74	1774512.42	86.11890
-150.00	80.00	492402.72	1774519.57	86.11891
-160.00	80.00	492370.70	1774526.73	86.11892
-110.00	90.00	492537.95	1774522.97	86.11893
-120.00	90.00	492505.93	1774530.13	86.11894
-130.00	90.00	492473.91	1774537.28	86.11895
-140.00	90.00	492441.89	1774544.44	86.11896
-150.00	90.00	492409.87	1774551.59	86.11897
-160.00	90.00	492377.85	1774558.75	86.11898
-170.00	90.00	492345.84	1774565.90	86.11899
-130.00	100.00	492481.07	1774569.30	86.11900
-140.00	100.00	492449.05	1774576.46	86.11901
-150.00	100.00	492417.03	1774583.61	86.11902
-160.00	100.00	492385.01	1774590.77	86.11903
-150.00	110.00	492424.18	1774615.63	86.11904
-160.00	110.00	492392.16	1774622.78	86.11905
-160.00	110.00	492399.32	1774654.80	86.11906
-10.00	30.00	492815.21	1774259.31	86.11907
-20.00	40.00	492790.34	1774298.48	86.11908
-40.00	50.00	492733.46	1774344.81	86.11909
-50.00	60.00	492708.60	1774383.99	86.11910
-60.00	60.00	492676.58	1774391.14	86.11911
-70.00	70.00	492651.71	1774430.32	86.11912
-80.00	80.00	492626.85	1774469.49	86.11913
-90.00	80.00	492594.83	1774476.64	86.11914
-90.00	90.00	492601.99	1774508.66	86.11915
-100.00	90.00	492569.97	1774515.82	86.11916
-110.00	100.00	492545.10	1774554.99	86.11917
-120.00	100.00	492513.08	1774562.15	86.11918
-130.00	110.00	492488.22	1774601.32	86.11919
-140.00	110.00	492456.20	1774608.47	86.11920
-150.00	120.00	492431.34	1774647.65	86.1192
-160.00	130.00	492406.47	1774686.82	86.119
-10.00	70.00	492843.83	1774387.39	86.119
-20.00	70.00	492811.81	1774394.54	86.11924
-30.00	80.00	492786.94	1774433.71	86.11925
-40.00	80.00	492754.92	1774440.87	86.11926
-50.00	80.00	492722.91	1774448.02	86.11927
-60.00	80.00	492690.89	1774455.18	86.11928
-70.00	90.00	492666.02	1774494.35	86.11929
-80.00	100.00	492641.16	1774533.53	86.11930
-90.00	100.00	492609.14	1774540.68	86.11931
-100.00	110.00	492584.28	1774579.85	86.11932
-110.00	110.00	492552.26	1774587.01	86.11933
-120.00	120.00	492527.39	1774626.18	86.11935
-130.00	120.00	492495.38	1774633.34	86.11936
-140.00	130.00	492470.51	1774672.51	86.11937
-150.00	130.00	492438.49	1774679.67	86.11938
-160.00	140.00	492413.63	1774718.84	86.11939

Fig. 10. Two-foot elevation contours and soil sampling locations for 1984 survey of Materials Disposal Area T.

Fig. 11. Two-foot elevation contours and soil sampling locations for 1986 survey of Materials Disposal Area T.

B. Survey results for soil radionuclide concentrations

The Laboratory's Environmental Surveillance Group has monitored regional soils located away from Los Alamos to provide natural and worldwide fallout background information for several radionuclides (13, 14). This data is summarized in Table 6 and was used to evaluate the 1984 and 1986 survey results at MDA-T. Radionuclide concentration contours were selected on the basis of (1) radionuclide concentrations below the mean background concentration, and (2) radionuclide concentrations as large as the mean background concentration plus twice the standard deviation of the mean background concentration. Thus, the latter contours presented in the following subsections of this report will represent the upper limit background concentration for that particular radionuclide (Table 6). The upper limit background level calculated this way leads to the statistical expectation that only 1 in 40 background samples analyzed will exceed the upper background concentration.

(1) The 1984 Survey Results

Since there were so few radionuclide assay results for samples collected from the 0-1 cm depth, this data was not considered in this report.

The tritium concentration contours are presented for the 1984 soil survey of MDA-T for the 1-10 cm sampling depth and for the 10-30 cm sampling depth in Figures 12 and 13, respectively. Based on these results, most of the soil samples collected in this survey were either below mean background concentration in soil (corresponding to

a gray color in the figures or mean) or background concentration plus twice the standard deviation of the mean background concentration (corresponding to a blue color in the figures). Tritium concentrations above this latter upper limit of background were found in only 4 locations at the 1-10 cm sampling depth (Fig. 12) and at only two locations at the deeper depth (Fig. 13). Most of the elevated tritium concentrations were found in samples collected within the fenced area of this disposal site. The highest concentrations were found in the deeper samples collected between the northern site fence and Absorption Bed 4 (Figs. 12 and 13). Due to the short half-life of tritium, the tritium concentrations currently in these same samples would be about half of the concentrations determined in 1984.

The plutonium concentration contours are presented in Figures 14 through 17 for the 1984 survey. In strong contrast to the tritium data, most of the samples collected were considerably above the upper limits of background concentrations for ^{238}Pu and ^{239}Pu , whether or not the samples were collected inside or outside of this disposal site's fence. In addition, the plutonium concentrations at both sampling depths usually were similar: a large change in concentrations did not usually occur with depth. The highest ^{238}Pu concentrations (1.0 - 10 pCi/g contour, corresponding to a contour with a yellow color in Figs. 14 and 15) occurred at two locations above the disposal shafts and at one location within the old CMP runway. Concentrations of soil ^{238}Pu ranging from 0.01 to 1 pCi/g (contours with blue green and dark green colors) dominated the areas to the north and south of the disposal site, as well as within the fence.

Table 6. Summary of Background Concentrations of Radionuclides in Soils of Northern New Mexico (13,14).

Radionuclide	Units	Mean Concentration	Upper Limit of Background (mean concentration plus 2 standard deviations)
^3H	pCi/l	2600	7200
^{238}Pu	pCi/g	0.001	0.005
^{239}Pu	pCi/g	0.007	0.025
^{241}Am	pCi/g	0.007	0.023

Fig. 12. Soil tritium concentration contours for the 1984 sampling grid at Materials Disposal Area T (1-10 cm depth).

Fig. 13. Soil tritium concentration contours for the 1984 sampling grid at Materials Disposal Area T (10-30 cm depth).

Fig. 14. Soil ^{238}Pu concentration contours for the 1984 sampling grid at Materials Disposal Area T (1-10 cm depth).

Fig. 15. Soil ^{238}Pu concentrations for the 1984 sampling locations at TA-21, Materials Disposal Area T (10-30 cm depth).

Fig. 16. Soil ^{239}Pu concentration contours for the 1984 sampling grid at Materials Disposal Area T (1-10 cm depth).

Fig. 17. Soil ^{239}Pu concentration contours for the 1984 sampling grid at Materials Disposal Area T (10-30 cm depth).

The highest concentrations of ^{239}Pu were found above the old CMP runway, in the western portion of MDA-T (Figs. 16 and 17). These are represented by ^{239}Pu concentration in these surface soil samples ranging from 10 to 100 pCi/g, designated as the yellow contours in Figures 16 and 17. Soil samples with 40- to 100-fold increased ^{239}Pu over the upper limit for background concentrations (contour with the dark green color in Figs. 16 and 17) seemed to be more dominant over the disposal site than corresponding contours for ^{238}Pu (Figs. 14 and 15). Although the exact reason for this observation is unknown at this time, a partial explanation may be derived from the waste use history of the site as presented earlier in this report: two- to four-fold more ^{239}Pu was in the waste than ^{238}Pu (on a radionuclide activity basis).

Another important point should be made to clarify the overall significance of the plutonium data collected in 1984. As we pointed out earlier, the soil samples collected only represent what occurred on the mesa tops, i.e. at elevations ranging from 7146 to 7100 ft at MDA-T. None of these samples reflect the impact of the treated and untreated liquid wastes discharged to DP Canyon (to the north of the disposal site).

(2) The 1986 Survey Results

The 1986 survey of the soil radionuclides at MDA-T involved samples collected at only one sampling depth, 0-5 cm. Whereas the 1984 sampling locations were on 20 m centers, the 1986 soil samples were collected 10 m apart, thus improving the accuracy of the radionuclide concentration contours.

Because of the more detailed data collected in this survey compared with the 1984 survey, larger land areas were found with higher plutonium concentrations than in the 1984 survey. Thus, when the radionuclide concentration contours were estimated for the disposal site larger land areas could be interconnected in more comprehensive pattern than could be accomplished in the 1984 survey. Using the ^{238}Pu concentration contours in the 1 to 10 pCi/g range (contours with the yellow color) as an example, the 1986 survey results show a northeast-southwest trending yellow contour proceeding across the western end of MDA-T encompassing an area of higher concentrations to the south (Fig. 18). This entire area was influenced by water erosion which occurred across this end of the disposal area for several years. ^{238}Pu and ^{239}Pu (Fig. 19) associated with soil was evidently transported

across the western portion of the site, proceeded in a southeastern direction along the fence (which is south of the north perimeter road adjacent to the north fence of the disposal site), crossed the road to the north of the site, and proceeded down the naturally-occurring drainage way starting between the 7120 ft and 7110 ft elevation contours (see Fig. 11).

Another important observation concerning the soil plutonium concentration contours involves the sampling results north of the north disposal site fence, an area characterized by an undisturbed pinyon juniper woodland. Except for the soil erosion phenomena described above, the samples collected north of the north perimeter road were almost consistently within the dark green-colored contours in Figures 18 and 19. This meant that soil ^{238}Pu and ^{239}Pu concentrations were consistently 0.1 to 1.0 pCi/g and 1 to 10 pCi/g, respectively. Estimates of the ratios of ^{239}Pu to ^{238}Pu were made for the samples collected across this area (Fig. 20), which demonstrate consistently observed ratios of 5 to 25. Although the reason for this is not fully understood at this time, this area probably received local airborne fallout from DP site which influenced this entire area. It is also possible that liquid effluents originally contained in absorption beds 3 and 4 overflowed during the early waste history of the site, and plutonium was transported to the low-elevation areas north of the disposal area. The plutonium ratios presented in Figure 20 suggest that more ^{239}Pu was contained in the surface soils than ^{238}Pu in the western portion of the disposal area. The reason for this observation is also not fully understood at this time, but the fact that the disposal shafts contained much lower $^{239}\text{Pu}/^{238}\text{Pu}$ ratios suggests an alternative source term. This alternate source term could have involved a high ^{239}Pu source which migrated into the disposal site from drainage areas west of this disposal site via site runoff near the southwestern corner of the site. Although ^{241}Am assays were not performed for the soil samples collected in 1984, this was a major concern in the 1986 survey (Fig. 21). Very large amounts of ^{241}Am were processed in the pug mill operations at this site, especially within the CMPs. It is not surprising then that the soils around the areas where the CMPs were filled with a plastic-wrapped fire hose contained the highest ^{241}Am concentrations found at the site (notice the dark green contour centered at the western end of the disposal shaft field).

Fig. 18. Soil ^{238}Pu concentration contours for the 1986 sampling grid at Materials Disposal Area T (0-5 cm depth).

Fig. 19. Soil ^{239}Pu concentration contours for the 1986 sampling grid at Materials Disposal Area T (0–5 cm depth).

Pu-239 concentrations (pCi/g) for the 1986 soil sampling locations at TA-21, MDA-T (0-5 cm depth)

LEGEND

Radionuclide concentrations (pCi/g):

100.000 & ABOVE	
10.000 TO 100.000	
1.000 TO 10.000	
0.100 TO 1.000	
0.025 TO 0.100	
0.007 TO 0.025	
BELOW	0.007

Fence

— **Absorption bed**

☐ **Soil sampling location**

- Disposal shaft (8-ft diam)

- Disposal shaft (6-ft diam)

Fig. 20. Soil ^{239}Pu : ^{238}Pu in soil samples collected in the 1986 sampling grid at Materials Disposal Area T (0-5 cm depth).

Fig. 21. Soil ^{241}Am concentration contours for the 1986 sampling grid at Materials Disposal Area T (0-5 cm depth).

The other area of notice (Fig. 21) is again the land north of the disposal site. The dominant bluegreen-colored contours in this area, corresponding to ^{241}Am concentrations ranging from 1 to 10 pCi/g, with the upper limit of ^{241}Am background concentrations being 0.33 pCi/g (dark blue-colored contours). Since this same trend was noticed with the soil plutonium results, similar speculated deposition mechanisms could have occurred for ^{241}Am .

V. USEFULNESS OF DATA ANALYSIS AND RECOMMENDATIONS FOR FUTURE STUDIES

The analysis of the surface soil sampling programs at MDA-T is potentially very useful to the Environmental Restoration Program, the site operator, the Environmental Surveillance Group, the Laboratory, and the waste management community in general. More specifically, this report serves to document two major past attempts to document the distribution of radionuclides at this waste site. There is already an on-going attempt to design another soil sampling program at this waste disposal site by the Environmental Restoration Program. Although the entire surface of MDA-T received a new soil cover in 1987, the radionuclide concentration contours presented in this report can be used to plan a subsurface soil sampling program based on previous information. The concept in this case would be to collect a constant number of samples per unit area within each radionuclide concentration contour. This would result in a much more cost efficient survey, which, based on our comparison of the 1984 and 1986 survey, should contain sample locations on (at least) 10 m centers. The survey results are now in a format which can be used to perform a human dose assessment analysis for this waste disposal site, and thus, subsequently make recommendations for site cleanup and remediation.

Several general recommendations can be made from the analysis of the 1984 and 1986 surveys at this waste site:

(1) Although the stated objectives of the original plan to monitor this disposal site (4) came close to being met in the 1984 and 1986 intensive surveys, an analysis of the results of the brief annual surveys would not be worth performing. The level of effort needed to adequately document these surveillance activities is not worth it for the small number of sample data collected (consequently, we also recommend that only detailed surveys should be performed in the future).

(2) Future soil radionuclide surveys should require a high documentation level by civil engineering surveyors and personnel in charge of describing sampling locations (in NMSP units).

(3) Detailed soil radionuclide surveys should be performed for subsurface (below 30 cm) regions of this and other, disposal sites.

(4) Analysis of surface soil radionuclide surveys such as performed in the current study should be performed for the other disposal areas at TA-21.

(5) Once (3) and (4) have been accomplished, the entire technical area should be analyzed so as to put together a comprehensive picture of the impact of local air-borne and water erosion patterns on the mesa top.

REFERENCES

1. "DOE Operating Guidelines for the Shallow Land Burial of Low-level Radioactive Waste," EG&G, Idaho, Interim Draft Number 1 (November 1978).
2. "DOE Site Design Criteria for the Shallow Land Disposal of Low-Level Radioactive Waste," EG&G, Idaho, Draft Number 1 (November 1981).
3. "Development of Monitoring Programs for ERDA Owned Radioactive Low-Level Waste Burial Sites," Dames & Moore, final report (July 1976).
4. W. R. Hansen, D. L. Mayfield, and L. J. Walker, "Interim Environmental Surveillance Plan for LASL Radioactive Waste Areas," Report to DOE, ALO, and Management Offices, Los Alamos Scientific Laboratory report LA-UR-90-3110 (October 1980).
5. Environmental Science Group, Environmental Surveillance Group, Health and Environmental Chemistry Group, and Waste Management Group, "Environmental Surveillance of Low-Level Radioactive Waste Management Areas at Los Alamos During 1986", Los Alamos National Laboratory report LA-UR-87-4121 (December 1987).

6. M. A. Rogers, "History and Environmental Setting of LASL Near Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T); A Source Document," Los Alamos Scientific Laboratory report LA-6848 (June 1977).
7. Anonymous, "Transuranic solid waste management research programs quarterly report, October-December 1973", Los Alamos Scientific Lab. Rep. LA-5614-PR (1974).
8. M. Burns, Laboratory Waste Management Group, personal communication, March 9, 1990.
9. K. Jacobsen, Laboratory Environmental Surveillance Group, personal communication, March 8, 1990.
10. Environmental Surveillance Group, Project A411 Records.
11. Environmental Surveillance Group, "Environmental Surveillance at Los Alamos During 1980", Los Alamos National Laboratory report LA-8810-ENV (April 1981).
12. Environmental Surveillance Group, "Environmental Surveillance at Los Alamos during 1986", Los Alamos National Laboratory report LA-10992-ENV (1987).
13. Environmental Surveillance Group, "Environmental Surveillance at Los Alamos During 1979," Los Alamos National Laboratory report LA-8200-ENV (April 1980).
14. Purtymun, W. D., R. J. Peters, T. E. Buhl, M. N. Maes, and F. H. Brown, "Background Concentrations of Radionuclides in Soils and River Sediments in Northern New Mexico, 1974-1986", Los Alamos National Laboratory report LA-11134-MS (November 1987).

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