4.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of soil contamination related to releases from the 903 Pad has been evaluated by analysis of radionuclide and chemical data obtained as described in Section 2. The primary objective of the investigation is to determine the areal extent and depth of radiological and organic contamination above Tier I RSALs and Tier I SSALs, respectively. Another objective of the investigation is to characterize ^{241}Am in surface soils to 10 pCi/g using gamma spectroscopy field instrumentation. This characterization would allow for identification of surface soils exceeding Tier II RSALs. Remedial alternatives will be evaluated in the IM/IRA decision document based on these criteria.

Detailed descriptions of contamination in surface and subsurface soil are presented in this section. Results of the HPGe survey of the Americium Zone are presented in Section 4.1. Sections 4.2 and 4.3, respectively, summarize radionuclide and VOC soil data collected for the 903 Pad and Lip Area. Descriptive summary statistics of the data are presented in Appendix E. Electronic copies of analytical results and Tier I and Tier II RSAL calculations are provided in Appendix F.

4.1 SOIL RADIOLOGICAL CONTAMINATION IN THE AMERICIUM ZONE

Results presented in this section are based on the double sampling technique in which HPGe measurements were correlated to alpha spectroscopy laboratory results. The linear regression between the HPGe results and laboratory results showed a high degree of correlation ($R > 0.97$), and was therefore used to standardize each HPGe measurement to laboratory derived alpha spectroscopy results (see Section 2.2.2). This provided an accurate model for estimating radiological contamination in surface soil relative to Tier I and Tier II RSALs at each survey location.

4.1.1 Comparison of HPGe Measurements to Tier I and Tier II RSALs

Based on 1,110 HPGe measurements in the Americium Zone (Figure 2-1), radiological contamination appears to extend approximately 1,050 feet east of the Lip Area. Surface soil contamination is defined by Tier I and Tier II RSAL exceedances, which are summarized in

Table 4-1. Using the best-fit regression model, nearly 37 % of the measurement locations exceed the Tier II RSALs. Less than 1% of the measurement locations exceed the Tier I RSALs. HPGe results and RSAL calculations are presented in Appendix F.

Table 4-1 Frequency of RFCA Tier I and Tier II RSAL Exceedances-HPGe Survey Results

HPGe Survey	Number of Measurements	Number Of Exceedances RFCA Tier I RSALs	Number Of Exceedances RFCA Tier II RSALs
Surface Soil	1110	4	416

The range of measured ^{241}Am, $^{239/240}$Pu, ^{235}U, and ^{238}U activities are presented graphically in Figure 4-1. Comparison of radionuclide results to Tier I and Tier II RSALs indicate that RSAL exceedances are due to elevated activities of $^{239/240}$Pu and ^{241}Am. For $^{239/240}$Pu, activities range from 6.32 pCi/g to 938.42 pCi/g with a mean value of 105.05 pCi/g. Approximately 7% of the $^{239/240}$Pu measurements exceed the Tier II RSAL of 252 pCi/g. None of the $^{239/240}$Pu measurements exceed the Tier I RSAL of 1429 pCi/g. ^{241}Am activities range from 4.91 pCi/g to 149.22 pCi/g with a mean value of 20.19 pCi/g. Approximately 10% of the ^{241}Am measurements exceed the Tier II RSAL of 38 pCi/g. Like $^{239/240}$Pu, none of the ^{241}Am measurements exceed the Tier I RSAL of 215 pCi/g. HPGe measurements for ^{235}U and ^{238}U were all below Tier I and Tier II RSALs.

4.1.2 Spatial Distribution of Radiological Contamination in the Americium Zone

Figure 4-2 shows the distribution of Tier I and Tier II RSAL exceedances in surface soil within the Americium Zone. The highest level of contamination as indicated by Tier I RSAL exceedances is isolated at a cluster of three locations near the northwest corner of the Americium Zone and at one location in the south central portion of the Lip Area. Tier II exceedances encompass nearly 37% of the Americium Zone Investigation Area. The HPGe data also define the extent of soil contamination by bounding the area with survey results that are below Tier II RSALs (Figure 4-2). The accuracy of the HPGe survey data is corroborated by historical data as discussed in Section 2.2.2.1. The HPGe data also indicate, as expected, non-contaminated areas where clean fill was used for the road south of the cement and wetland areas, and for the road that borders the western and northern perimeter of the Americium Zone.

The Tier I and Tier II RSAL exceedances are associated with elevated activities of $^{239/240}$Pu and ^{241}Am. The distribution of ^{241}Am activities is shown in Figure 4-3. The highest activities of ^{241}Am exceed 140 pCi/g near the northwest corner of the Americium Zone. As shown, the distribution of ^{241}Am Tier II RSAL exceedances trend in a northeast-southwest orientation, which extends from the southwest corner of the Lip Area to the north-central portion of the Americium Zone. The distribution of $^{239/240}$Pu activities in surface soil (Figure 4-4) is similar to that of the ^{241}Am activities, with the highest activities exceeding 900 pCi/g near the northwest corner of the Americium Zone. The pattern of Tier I RSAL exceedances is also similar to that observed for ^{241}Am, with a northeast-southwest trend of contamination. This trend is a result of contaminant deposition from the source area. The similar spatial configurations of ^{241}Am and $^{239/240}$Pu are to be expected because ^{241}Am is a daughter product of weapons grade plutonium decay.

4.1.3 FIDLER Surveys

A FIDLER survey was conducted at HPGe measurement location 301 (Figure 2-1) where an isolated HPGe measurement (direct field measurement) exceeded the 10 pCi/g ^{241}Am decision level. The FIDLER survey was used to determine if the result was caused by the presence of a smaller area containing a hot spot. It should be noted that all ^{241}Am activities discussed in this section are presented as direct field measurements. The activity of ^{241}Am from the *in situ* HPGe measurement location 301 was 10.977 pCi/g and the surrounding HPGe measurements were less than 10 pCi/g. FIDLER survey results ranged from 1,224 to 2,841 cpm with a mean of 2,056 cpm. Background measurements of 910 and 1,107 cpm for the two FIDLERs used for the survey were taken at the step-off pad on the north side of the Americium Zone, adjacent to the East Access Road. Because of the low level of ^{241}Am detected in the soil and two FIDLER instruments used for the survey, the results are qualitative at best. However, contamination appears to be homogeneous as would be expected at this distant location from the source where contamination is a result of wind dispersal of plutonium contaminated soil from the 903 Pad and Lip Area.

FIDLER surveys were also conducted at HPGe locations 460 and 462 (Figure 2-1) where surface soils exceeded the RFCA Tier I RSALs. The surveys were conducted to determine whether contamination was homogeneous and widespread as suggested by the conceptual model, or

heterogeneous consisting of numerous individual hot spots. The activities of ^{241}Am from the *in situ* HPGe measurements were 115.74 and 109.04 pCi/g for HPGe measurement locations 460 and 462, respectively, and the surrounding HPGe measurements were less than 100 pCi/g. FIDLER survey results for HPGe measurement location 460 ranged from 2,928 to 17,039 cpm with a mean of 8,293 cpm. FIDLER survey results for FOV 462 ranged from 3,466 to 15,331 cpm with a mean of 8,729 cpm. Background measurements of 1,430 and 2,127 cpm for the two FIDLERs were taken at the step-off pad on the southwest corner of the Americium Zone, adjacent to the access road for the old firing range. Because two FIDLER instruments were used for the surveys, the results are qualitative. However, contamination appears to be heterogeneous and consists of numerous individual hot spots as might be expected from soil disturbance, localized erosional paths, or depositional areas near the source of contamination.

4.2 SOIL RADIOLOGICAL CONTAMINATION IN THE 903 PAD AND LIP AREA

Surface and subsurface soil samples were analyzed for ^{241}Am, $^{239/240}$Pu, $^{233/234}$U, ^{235}U, and ^{238}U using alpha spectroscopy methods. Surface and subsurface soil samples were aggregated into four native soil horizons (Native 1 [0-6 in], Native 2 [6-12 in], Native 3 [12-18 in], Native 4 [18-24 in]), bedrock soil, and artificial fill under the 903 Pad. Artificial fill in the Lip Area was classified as Native 1 soil because native soil and artificial fill could not be differentiated in the field.

Based on the radiological results, contamination appears to be confined to the top 1.5 feet of native soil, and is most extensive in the Native 1 soil horizon. Table 4.2 summarizes the Tier I and Tier II RSAL exceedances. The frequency of Tier I and II exceedances decreases with increasing depth. No samples collected beneath the Native 3-soil horizon exceeded Tier I and Tier II RSALs.[3] Radiological data and RSAL SOR calculations for surface and subsurface soil are presented in Appendix F.

[3] Radiological sample results from the subsurface VOC investigation indicate no contamination above Tier II RSALs. Activities of all measured radionuclides from the VOC investigation were below 3 pCi/g.

Table 4-2 Frequency of RFCA Tier I and Tier II RSAL Exceedances-Native Soil Results

Geologic/Fill Material	Number of Measurements	Frequency Of Exceedances RFCA Tier I RSALs	Frequency Of Exceedances RFCA Tier II RSALs
Asphalt	9	N/A	N/A
Bedrock	12	0	0
Fill	12	0	1
Native	72	0	0
Native 1	62	17	34
Native 2	62	5	11
Native 3	62	0	3
Native 4	58	0	0

N/A Not Applicable; Asphalt samples were not comparable to RSALs

4.2.1 Radionuclide Activities in Native Soils

The range of activities for ^{241}Am, $^{239/240}$Pu, $^{233/234}$U, ^{235}U, and ^{238}U in Native 1, Native 2, and Native 3 soil types are shown graphically in Figure 4-5. As discussed in the following subsections, the amount of contamination decreases significantly with depth.

4.2.1.1 Native 1 Surface Soil Contamination

The Native 1 soil has the most extensive contamination as indicated by activities of ^{241}Am, $^{239/240}$Pu and ^{231}U that exceed Tier I and Tier II RSALs (Table 4-2 and Figure 4-5). ^{238}Uranium activities range from 0.49 pCi/g to 780 pCi/g with a geometric mean value of 1.99 pCi/g[4]. The high activity of 780 pCi/g is the only exceedance above Tier I and Tier II RSALs of 586 pCi/g and 103 pCi/g, respectively. Approximately 44 percent of the $^{239/240}$Pu and ^{241}Am results exceed Tier II RSALs.

$^{239/240}$ Pu activities range from 0.82 pCi/g to 152,260 pCi/g with a geometric mean value of 146.69 pCi/g. For $^{239/240}$Pu, 15% of the samples exceed the Tier I RSAL of 1,429 pCi/g and 44% of the samples exceed the Tier II RSAL of 252 pCi/g. ^{241}Am activities in Native 1 soil appear more extensive than that of ^{239}Pu with activities ranging from 0.15 pCi/g to 31,670 pCi/g. For

[4]The data appear to have a lognormal distribution, and therefore, a geometric mean is a better measure of the central tendency of the distribution.

^{241}Am activities, 19.1% of the samples exceed the Tier I (215 pCi/g) RSAL and 47.1% exceed the Tier II (38 pCi/g) RSAL.

4.2.1.2 Native 2 Subsurface Soil Contamination

The Native 2 soil horizon is substantially less contaminated than the Native 1 soil horizon but still contains activities above Tier I and Tier II RSALs for ^{241}Am and $^{239/240}$Pu (Figure 4-5). $^{239/240}$Pu activities range from 0.14 pCi/g to 1,820 pCi/g with a geometric mean of 8.65 pCi/g. For $^{239/240}$Pu, 0.03% of the samples exceed the Tier I RSAL (1,429 pCi/g) and 11% of the samples exceed the Tier II RSAL (252 pCi/g). ^{241}Am activities range from non-detectable (0.03 pCi/g) to 406 pCi/g with a geometric mean value of 1.79 pCi/g. ^{241}Am contamination is similar to that of $^{239/240}$Pu contamination as indicated by frequency of exceedances of 0.03% and 11% above Tier I (215 pCi/g) and Tier II (38 pCi/g) RSALs, respectively.

4.2.1.3 Native 3 Subsurface Soil Contamination

The amount of contamination in the Native 3 soil is minimal relative to the Tier II RSALs (Figure 4-5). Only one sample for ^{241}Am exceeds the corresponding Tier II RSAL of 38 pCi/g. ^{241}Am in the Native 3 soil horizon ranges from non-detectable to 54.40 pCi/g with a median value of 0.23 pCi/g.[5] Activities of $^{239/240}$Pu in the Native 3 soil horizon were below the respective Tier I and Tier II RSALs.

4.2.2 Spatial Distribution of Contamination

Examination of the spatial distribution of contamination is useful for evaluating potential sources and contaminant migration pathways. This section discusses the spatial distribution of Tier I and Tier II RSALs for Native 1, Native 2, and Native 3 soil horizons. Also presented are the spatial distributions of $^{239/240}$Pu and ^{241}Am activities because of their exceedance of Tier I and Tier II RSALs.

[5] Due to the negative activities in the data set, the median value was used as a measure of the central tendency of the distribution instead of the geometric mean.

4.2.2.1 Spatial Distribution of Radionuclides in the Native 1 Soil Horizon

As shown in Figure 4-6, Tier I and Tier II RSAL exceedances (>1 for the sum of ratios) in Native 1 soil are located throughout the 903 Pad and Lip Area. There is no distinct pattern to the Tier I and Tier II exceedances at the 903 Pad. Most of the southern boundary and portions of the northern boundary do not exceed Tier II RSALs. For the Lip Area, Tier I exceedances are most prevalent in the center area due east of the 903 Pad, with Tier II exceedances surrounding this area. Relatively "clean" areas as indicated by RSALs less than Tier II are located further to the east and south of the 903 Pad. Apparent spatial gaps in contamination may be explained by past remedial activities. For example, the soil in the Lip Area was graded back toward the 903 Pad during past remedial actions, and therefore the soil closest to the Pad is not as contaminated as the soil near the central portion of the Lip Area. Similar remedial activities in 1984 removed contaminated soil in the western portion of the Lip Area.

The RSAL exceedances are associated with elevated levels of $^{239/240}$Pu and ^{241}Am. Figure 4-7 shows the distribution of ^{241}Am in the Native 1 surface soil. The highest ^{241}Am activities exceed 30,000 pCi/g and are centered near boring 91598 (Figure 4-7). However, as shown in Figure 4-7, the majority of the Native 1 soils in the 903 Pad (approximately half of the Native 1 soil) and Lip Area exceed the Tier II RSAL for ^{241}Am of 38 pCi/g. The distribution of the $^{239/240}$Pu activities is similar to that of the ^{241}Am activities, with the highest activities exceeding 150,000 pCi/g at boring 91598 (Figure 4-8). Like ^{241}Am, the $^{239/240}$Pu activities are elevated with respect to the Tier II RSAL (252 pCi/g) in most of the Native 1 soil within the 903 Pad and approximately half of the Native 1 soil in the Lip Area.

4.2.2.2 Spatial Distribution of Radionuclides in the Native 2 Soil Horizon

Figure 4-9 shows the distribution of the Tier I and Tier II RSAL exceedances (>1 for the sum of ratios) in the Native 2 soil horizon. The RSAL exceedances are not as ubiquitous as in the Native 1 soil horizon. RSAL exceedances are isolated to an area around boreholes 91398, 91598, 91898, and 91998 at the 903 Pad and around several boreholes throughout the Lip Area (boreholes 94898, 94998, 95198, 95398, 95498, 95598, and 97598). Like the Native 1 soil horizon, RSAL exceedances in the Native 2 soil horizon are associated with elevated levels of ^{241} Am and ^{239}Pu.

^{241}Am activities exceed 400 pCi/g in the 903 Lip Area with the highest activity observed at boring 95198 (Figure 4-10). The distribution of Pu-239 in the Native 2 soil horizon is very similar to that of ^{241}Am (Figure 4-11). ^{239}Pu exceeds 18,000 pCi/g (above the Tier I RSAL) at boring 95198. $^{239/240}$Pu activities exceeding the Tier II RSAL (252 pCi/g) are distributed like the ^{241}Am activities (Figure 4-11). The $^{239/240}$Pu and ^{241}Am activities in the Native 2 soil horizon are generally one to two orders of magnitude less than those observed in the Native 1 soil horizon.

Historical grading activity at the 903 Pad likely explains the somewhat different $^{239/240}$Pu and ^{241}Am distributions between Native 1 and Native 2 soils. For example, grading activities at boring 91998 may have redistributed contamination in Native 1 soil leaving higher contaminated soils in the Native 2 soil horizon. In the Lip Area, the amount of artificial fill in the Native 1 soil horizon would explain higher activities in Native 2 soil relative to the Native 1 soil.

4.2.2.3 Spatial Distribution of Radionuclides in the Native 3 Soil Horizon

Figure 4-12 shows the distribution of the Tier II RSAL exceedances (>1 for the sum of ratios) in the Native 3 soil horizon.[6] The amount of radionuclide contamination in the Native 3 soil horizon is significantly less than that in the Native 1 and Native 2 soil horizons. Tier II RSAL exceedances are isolated along the northern boundary of the Lip Area at borings 94898 and 95198. One other isolated Tier II RSAL exceedance is observed east of the 903 Pad at boring 95498. Like the Native 1 and Native 2 soil horizons, the RSAL exceedances within the Native 3 soil horizon are associated with elevated levels of ^{241}Am and $^{239/240}$Pu.

As shown in Figure 4-13, elevated levels of ^{241}Am with respect to the Tier II RSAL (38 pCi/g) are observed along the northern boundary of the Lip Area at boring 94898. Another area east of the 903 Pad near boring 95498 shows relatively high activities of ^{241}Am (up to 26 pCi/g) but these activities are slightly less than the Tier II RSALs.[7] The spatial distribution of ^{239}Pu in the Native 3 soil horizon is similar to that of ^{241}Am (Figure 4-14). Although none of the $^{239/240}$Pu samples exceed Tier I or Tier II RSALs, the relatively high activities near borings 94898 and 95498 contribute to the Tier II RSAL exceedances at these locations.

[6] Tier I RSAL exceedances were not observed in the Native 3 Soil horizon.
[7] Tier I RSAL exceedances for ^{241}Am were not observed in the Native 3 Soil horizon.

Overall, the area of ^{241}Am and $^{239/240}$Pu contamination decreases significantly with depth. Despite nearly identical spatial trends, the ^{241}Am and ^{239}Pu activities within the Native 3 soil horizon are an order of magnitude less than those within the Native 2 soil horizon.

4.2.3 Radionuclide Activities in 903 Pad Asphalt and 903 Pad Artificial Fill

Asphalt samples from the 903 Pad were collected to obtain preliminary estimates of the sample variance and mean for waste characterization purposes.[8] Random sampling techniques were used as an appropriate method to estimate the population mean and to determine the total amount of contamination. Nine asphalt samples were collected from sample locations randomly selected from the twenty-five 903 Pad subsurface soil sampling locations as shown in Figure 4-15. Asphalt thickness ranged from 0.4 to 0.7 feet with an average thickness of 0.5 feet.
Twelve artificial fill samples were collected from locations randomly selected from the twenty-five 903 Pad subsurface soil sampling locations as shown in Figure 4-16. Artificial fill thickness ranged from 0.3 to 0.9 feet with an average thickness of 0.5 feet beneath the 903 Pad. Artificial fill results were compared to RFCA Tier I and Tier II RSALs. Samples were analyzed for ^{241}Am, $^{239/240}$Pu $^{233/234}$U, ^{235}U, and ^{238}U, using alpha spectroscopy methods. The descriptive summary statistics are provided in Appendix E.

4.2.3.1 Radionuclide Distribution in Asphalt

The radionuclide activities in asphalt were low relative to the activities observed in the Native 1 soil horizon. As shown in Figures 4-15 and 4-17, the activities for ^{241}Am, $^{239/240}$Pu, $^{233/234}$U, ^{235}U, and ^{238}U are all below 1.5 pCi/g. The mean, standard deviation, and other descriptive statistics are summarized in Table 4-3.

Figure 4-15 shows the distribution of radionuclides in asphalt. With the exception of ^{238}U, the highest radionuclide activities in asphalt are present at boring 91898 ($^{233/234}$U [1.13 pCi/g], ^{235}U [0.133 pCi/g], ^{241}Am [0.341 pCi/g], and $^{239/240}$Pu [1.22 pCi/g]). The highest ^{238}U (0.919 pCi/g) activity in asphalt was reported at boring 90198.

[8] Asphalt samples were not comparable to RSALs, which are based the physical and chemical properties of soil. Instead, waste disposal WAC requirements for asphalt will be based on the mean and variance.

Table 4-3 Descriptive Summary Statistics for 903 Pad Asphalt

Descriptive Statistic	$^{233/234}U$ (pCi/g)	^{235}U (pCi/g)	^{238}U (pCi/g)	$^{239/240}Pu$ (pCi/g)	^{241}Am (pCi/g)
Mean	0.81	0.05	0.75	0.16	0.07
Geometric Mean	0.80	0.04	0.74	N/A	0.04
Standard Error	0.05	0.01	0.04	0.13	0.03
Median	0.78	0.04	0.75	0.03	0.04
Standard Deviation	0.15	0.03	0.13	0.40	0.10
Sample Variance	0.02	0.00	0.02	0.16	0.01
Kurtosis	1.70	7.01	-1.60	8.85	8.28
Skewness	1.22	2.46	-0.08	2.97	2.84
Coefficient of Variation	0.19	0.72	0.17	2.42	1.46
Range	0.47	0.12	0.32	1.22	0.33
Minimum	0.66	0.01	0.60	0.00	0.02
Maximum	1.13	0.13	0.92	1.22	0.34
Sum	7.27	0.42	6.74	1.48	0.63
Count	9	9	9	9	9
Confidence Level (90.0%)	0.08	0.02	0.07	0.22	0.06

N/A Not Applicable.

4.2.3.2 Radionuclide Distribution in 903 Pad Artificial Fill

The ranges of activities for the measured isotopes in artificial fill are presented in Figure 4-17. Overall, the radionuclide activities in artificial fill are low relative to the activities observed in the Native 1, Native 2, and Native 3 soil horizons. However, one Tier II RSAL exceedance is observed within the 903 Pad Area at boring 91898 (Figure 4-16). The Tier II RSAL exceedance is associated with elevated levels of ^{241}Am (126 pCi/g) and $^{239/240}Pu$ (558 pCi/g), which both exceed the respective Tier II RSALs of 38 pCi/g and 252 pCi/g. ^{241}Am activities in artificial fill range from 0.02 pCi/g to 126 pCi/g with a geometric mean value of 1.18 pCi/g. Elevated activities within the artificial fill appear to be isolated around this single boring considering that the highest $^{233/234}U$ (2.02 pCi/g), ^{235}U (0.49 pCi/g), $^{233/234}U$ (2.77 pCi/g), and $^{239/240}Pu$ (558 pCi/g) activities were also observed at boring 91898 (Figure 4-17). Descriptive summary statistics for the 903 Pad artificial fill are presented in Table 4-4.

Table 4-4 Descriptive Summary Statistics for 903 Pad Artificial Fill

Descriptive Statistic	$^{233/234}U$ (pCi/g)	^{235}U (pCi/g)	^{238}U (pCi/g)	$^{239/240}Pu$ (pCi/g)	^{241}Am (pCi/g)
Mean	1.06	0.09	1.15	53.75	12.01
Geometric Mean	1.02	0.06	1.00	5.78	1.18
Standard Error	0.11	0.04	0.18	45.95	10.38
Median	0.98	0.06	1.13	4.48	0.85
Mode	0.84	0.07	1.24	N/A	N/A
Standard Deviation	0.38	0.13	0.61	159.19	35.97
Sample Variance	0.14	0.02	0.37	25340.90	1294.08
Kurtosis	4.79	11.19	5.53	11.88	11.90
Skewness	1.51	3.30	1.72	3.44	3.44
Coefficient of Variation	0.36	1.43	0.53	2.96	2.99
Range	1.61	0.49	2.60	557.99	125.98
Minimum	0.41	0.00	0.17	0.01	0.02
Maximum	2.02	0.49	2.77	558.00	126.00
Sum	12.25	1.00	13.33	642.14	143.51
Count	12	12	12	12	12
Confidence Level (90.0%)	0.18	0.06	0.29	75.59	17.08
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	1	1

N/A Not Applicable

4.3 SUBSURFACE SOIL VOC INVESTIGATION

Seventeen boreholes were completed during the recent 903 Pad Investigation to characterize organic contamination at the 903 Pad and Lip Area, which included the planned 13 boreholes and four "step-out" boreholes (Figure 4-18). Subsurface soil organic COCs include CCL_4, PCE, TCE, 1,2-DCE, methylene chloride, and Aroclor-1248.[9]

Despite the absence of observed DNAPLs during the recent 903 Pad Investigation, VOCs were detected at several boring locations. Figure 4-18 summarizes the results of the VOC subsurface

[9] Screened from historical OU2 RI/RFI data (DOE, 1993).

soil investigation. As shown, detections of methylene chloride ranged from 0.59 ug/kg in borehole 97098 (8.4 to 8.8 ft) up to 1700 ug/kg in borehole in 92598 (16 to 16.75 ft). Detections of CCl_4 ranged from 2.3 ug/kg in borehole 96698 (22.4 to 22.8 ft) up to 5.3 ug/kg in borehole 96798 (20.4 to 20.8 ft). Detections of PCE ranged from 1.1 ug/kg in borehole 97698 (8.2 to 8.6 ft) up to 6,100 ug/kg in borehole 90998 (3.8 to 4.0 ft). Detections of TCE ranged from 0.89 ug/kg in borehole 96698 (20.4 to 20.8 ft) up to 290 ug/kg in borehole 90998 (3.8 to 4.0 ft). Detections of 1,2-DCE ranged from 1.1 ug/kg in boreholes 96798 (12.5 to 12.9 ft) and 97698 (8.2 to 8.6 ft) up to 4,400 ug/kg in borehole 90998 (3.8 to 4.0 ft). Review of historical data also indicate the presence of Arochlor-1248 and TCE above proposed SSALs (Figure 4-19). As shown, Aroclor-1248 was detected at 7200 ug/kg at boring 33291(0 to 6 ft) and TCE was detected at 5700 ug/kg at boring 21893 (23.1 to 23.4 ft). In general, the majority of the VOC detections were observed in the northeastern quadrant of the 903 Pad at borings 90998, 95998, 96498, 96698, 96798, and 97698. VOC detections were also observed in the 903 Lip Area at boring 97298 and within the central portion of the 903 Pad at boring 96898. The ranges of VOC concentrations are presented in Figure 4-20.

No VOC detections exceeded the current Tier I Subsurface SALs (Table 4-5). However, proposed Subsurface SALs are 1 to 4 orders of magnitude less than the current Tier I Subsurface SALs (Table 1-2). In general, the majority of the VOC detections above proposed RFCA Subsurface SALs were observed beneath the 903 Pad (Figure 4-19). The VOCs that exceed the proposed Tier II SSALs include PCE, TCE, and methylene chloride (Table 4-5). Methylene chloride was the most ubiquitous of the contaminants, exceeding the proposed Tier I Subsurface SAL at borings 90998, 91198, and 92598. PCE was detected once above the proposed Tier I Subsurface SAL at boring 90998. TCE was detected once above the proposed Tier I Subsurface SAL at boring 21893, which is located approximately 320 feet south of the 903 Pad.

The depth of contamination (relative to the proposed Tier I Subsurface SAL) beneath the 903 Pad varies from 3.8 feet at boring 90998 to 19.8 feet at boring 91198. Methylene chloride concentrations at boreholes 92598 and 91198 generally increase with depth, suggesting that the parent contaminant was released from the surface. However, TCE contamination south of the 903 Pad at boring 21893 appears to be isolated at a depth of 23.1 to 23.4 feet bgs. Given that the

average depth to water in this location is approximately 10 feet bgs (EG&G, 1995), TCE soil contamination is likely associated with the local ground water plume.

Organic compounds that exceed the proposed Tier II Subsurface SALs include PCE, TCE, 1,2-DCE, methylene chloride, and Aroclor-1248. As shown in Figure 4-19, the proposed Tier II exceedances are observed at boreholes 97698 (methylene chloride, PCE), 96498 (PCE), 90998 (methylene chloride, PCE, TCE, and 1,2-DCE), 95998 (PCE), 96798 (PCE), 12991 (methylene chloride), 91198 (methylene chloride), 92598 (methylene chloride), 96398 (methylene chloride), 97198 (methylene chloride), and 33291 (Aroclor-1248). The majority of the proposed Tier II Subsurface SAL exceedances occur beneath the 903 Pad. Methylene chloride occurs at 7 of the borings, followed by PCE, which occurs at five of the borings. The depth of contamination (relative to the proposed Tier II Subsurface SALs) varies from 0.0 feet bgs at boring 33291 to 26.9 feet bgs at boring 12991.

Some of the deeper borehole samples may reflect solute (dissolved) concentrations in ground water rather than concentrations in soil. Ground water beneath the 903 Pad is relatively shallow with depth to water averaging approximately 19 feet bgs. Depth to water in the Lip Area, located south of the 903 Pad, is much shallower as indicated by an average depth to water of 10 feet bgs. During high flow regimes, depth to water may decrease to 12 feet bgs beneath the 903 Pad and to 8 feet bgs in the Lip Area. Therefore, it is likely that detections of CCL_4, PCE **,** methylene chloride and TCE observed at depths greater than 19 feet at boreholes 97698, 95998, 91198, 12991, 97198, 96798, 21893 may represent partitioning of VOCs between the aqueous and solid phases.

Table 4-5 Frequency of VOC SSAL Exceedances in Subsurface Soil.

VOC	Number of Measurements	Number of Detections	Number Of Exceedances Current Tier I SSAL	Number Of Exceedances Proposed Tier I SSAL	Number Of Exceedances Proposed Tier II SSAL
Carbon Tetrachloride	86	3	0	0	0
PCE	86	19	0	1	7
TCE[1]	87	7	0	1	2
1,2-DCE	32	1	0	0	1
Methylene Chloride[1]	87	43	0	10	23
Aroclor-1248[2]	N/A	1	0	0	1

[1] Includes historical OU2 data.
[2] Based on screening of historical OU2 data only.

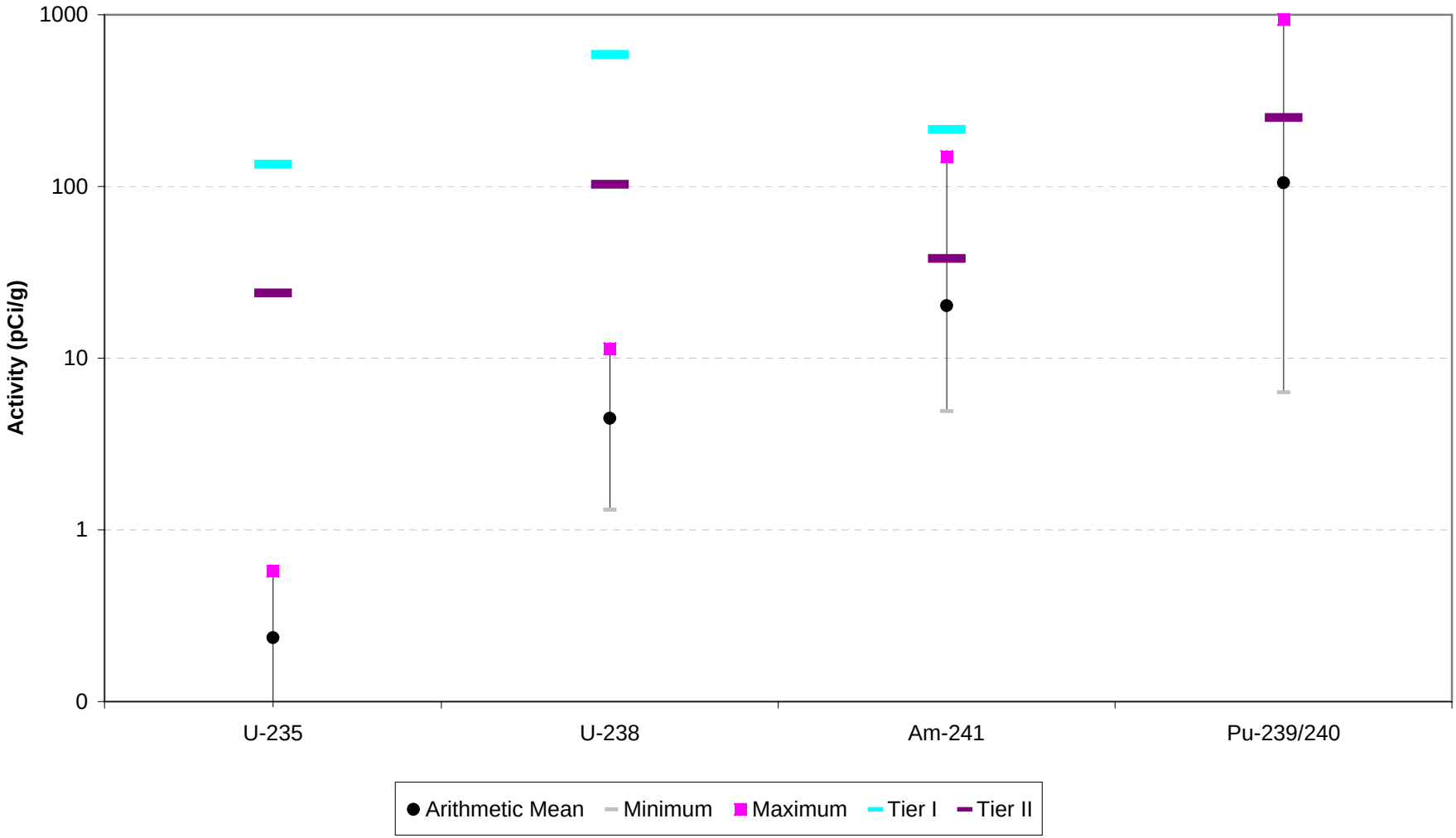
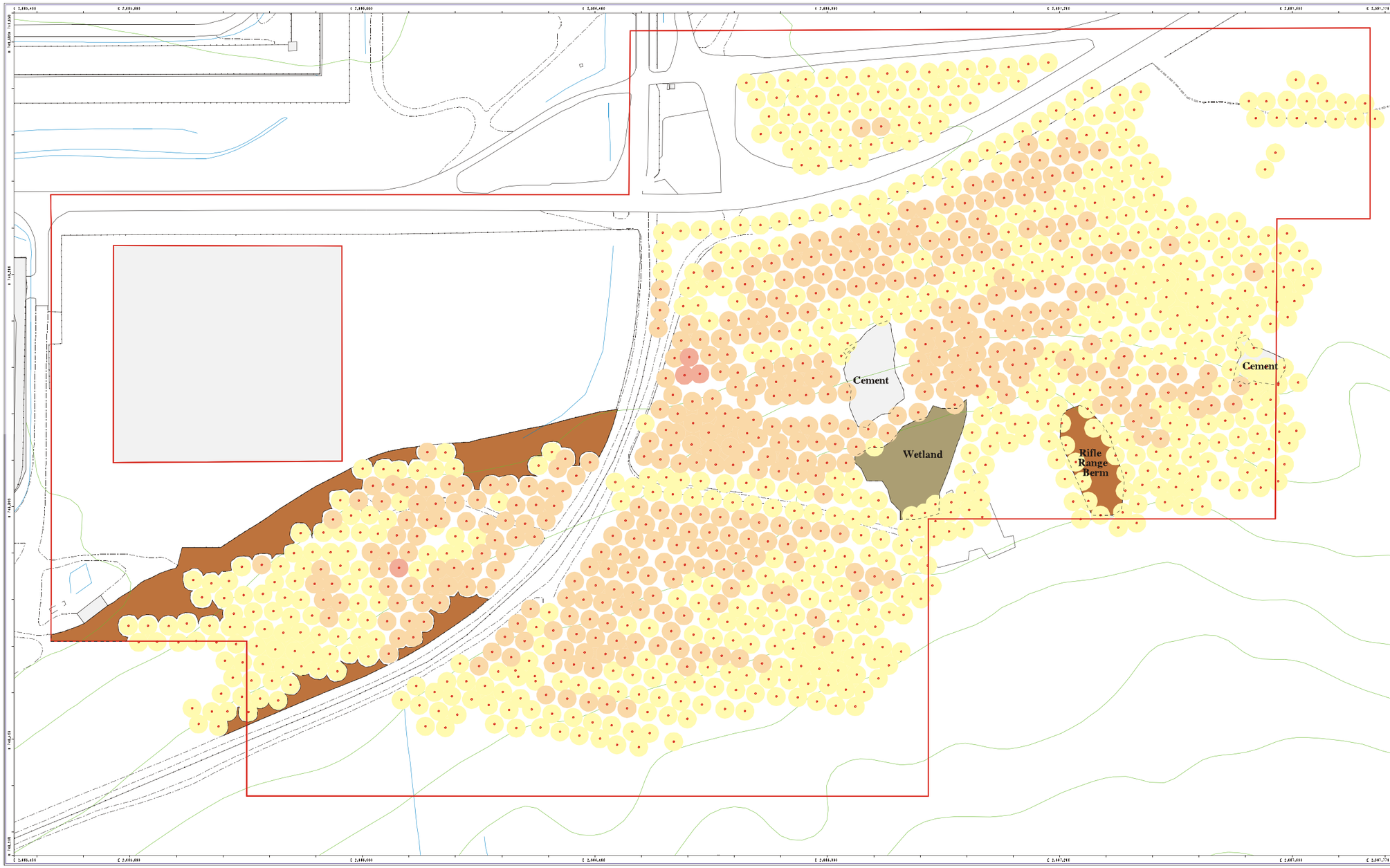


Figure 4-1 Range of Radionuclide Activities in Surface Soil - HPGe Survey



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

RSAL Exceedances in Surface Soil using Best Fit Line - HPGe Survey

Figure 4-2

EXPLANATION

- Gamma Survey Locations
- Investigative Area

HPGe Data Ranges

- Below Tier II Action Levels
- Exceeds Tier II Action Levels
- Exceeds Tier I Action Levels

TR = Trench

HPGe = HPGe Measurement

AME = Actinide Migration Evaluation

Standard Map Features

- Steep Topography
- Wetland Area
- Cement
- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

Scale = 1 : 2160
1 inch represents 180 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by:

DynCorp
THE ART OF TECHNOLOGY

Prepared for:

MAP ID: 00-0445

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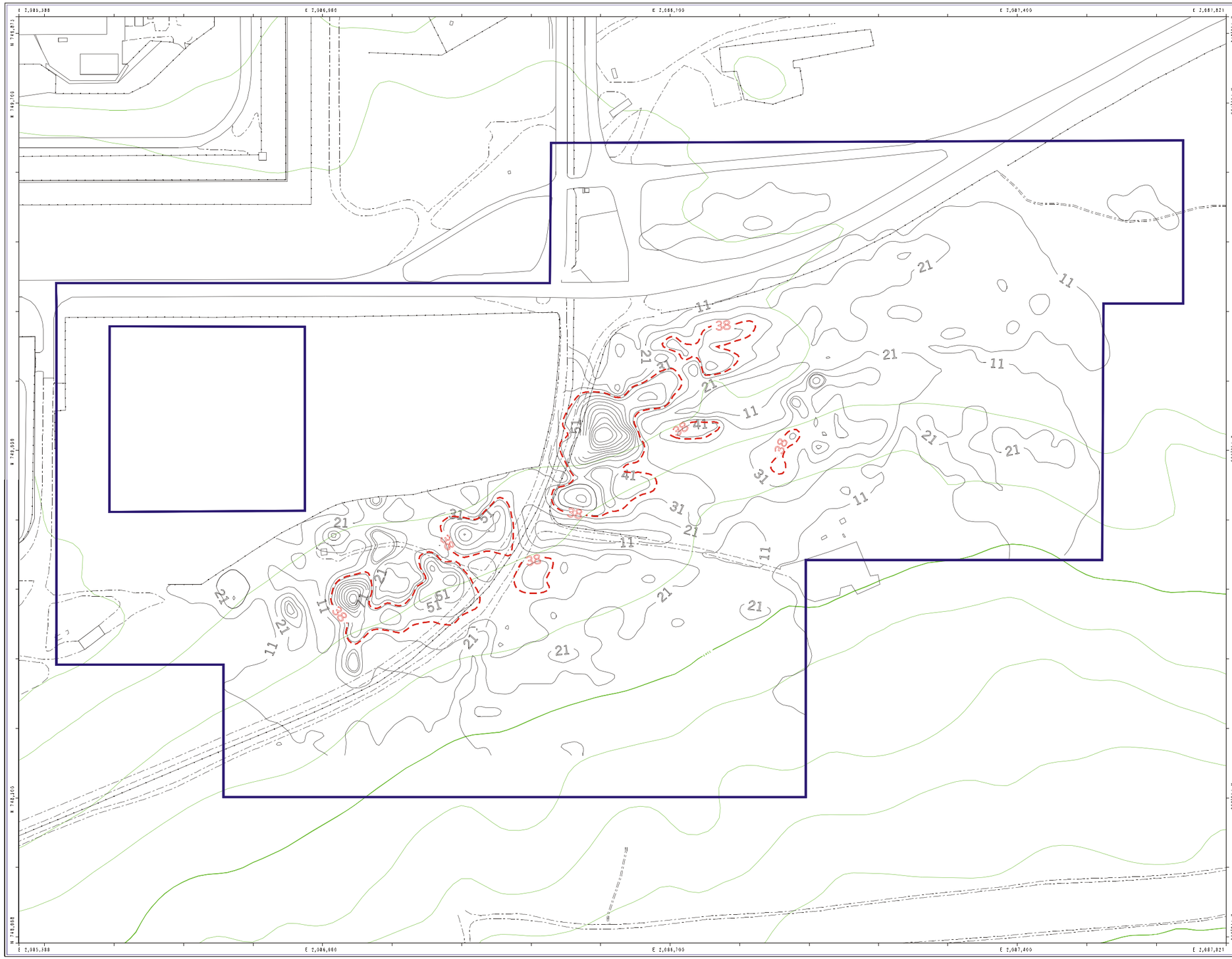
NT_Svr w:/projects/fy99/99-0445/tier_bestfit-bb.aml



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Am-241 in Surface Soil - HPGe Survey

Figure 4-3

EXPLANATION

- Am-241 Levels and Isoactivity Contour (Contour Interval = 10 pCi/g)
- Extent of RFCA Tier I Exceedances (215 pCi/g)
- Extent of RFCA Tier II Exceedances (38 pCi/g)
- Investigation Area

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 2410
1 inch represents approximately 201 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for:

MAP ID: 99-0408

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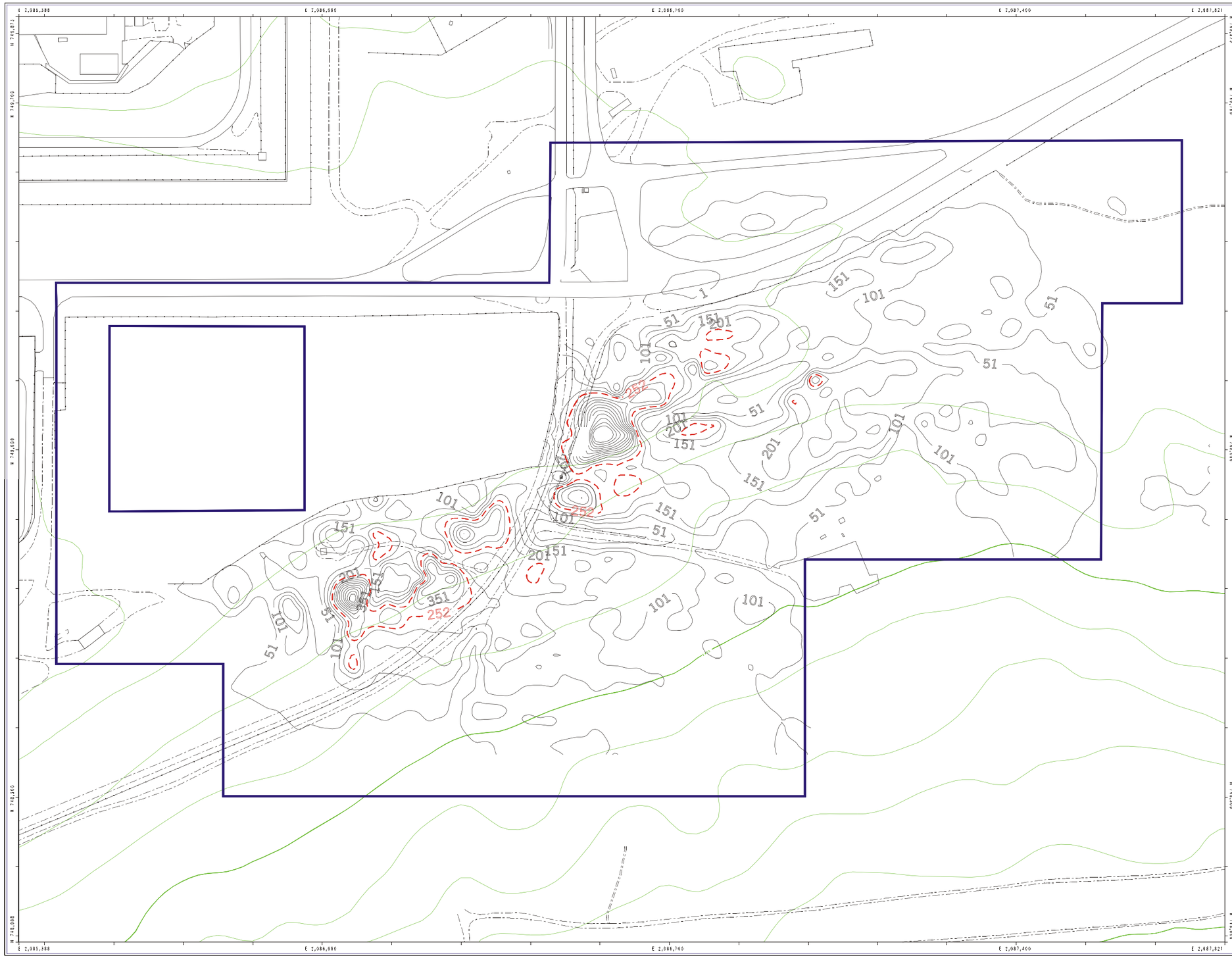
NT_Svr w:/projects/fy99/99-0408/am-241.aml



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Pu-239/240 in Surface Soil - HPGe Survey

Figure 4-4

EXPLANATION

- Pu-239/240 Levels and Isoactivity Contour (Contour Interval = 100 pCi/g)
- Extent of RFCA Tier I Exceedances (1429 pCi/g)
- Extent of RFCA Tier II Exceedances (252 pCi/g)
- Investigation Area

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post processing performed by MK, Winter 1997.

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N

Scale = 1 : 2410
1 inch represents approximately 201 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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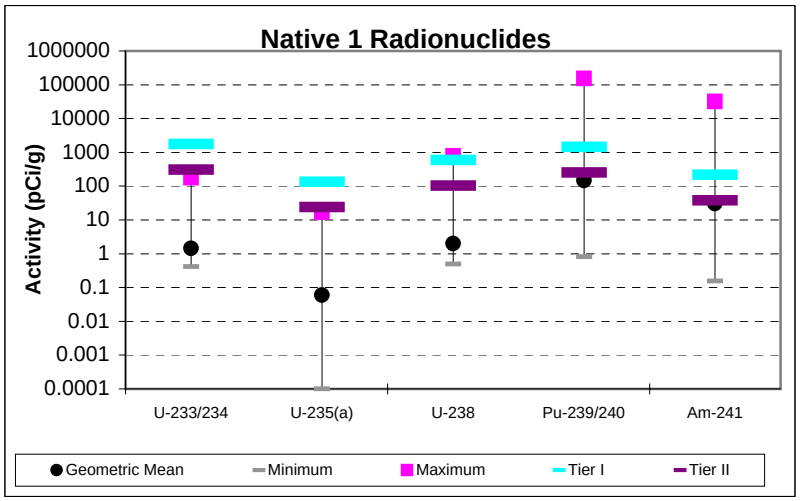
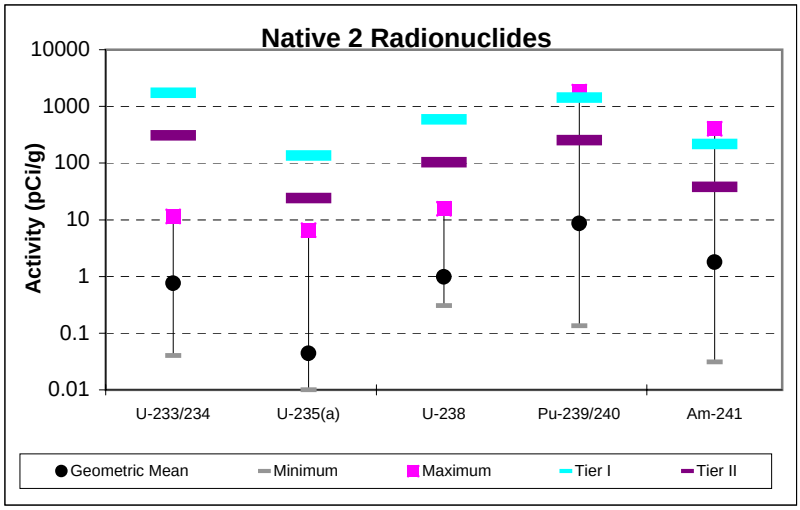
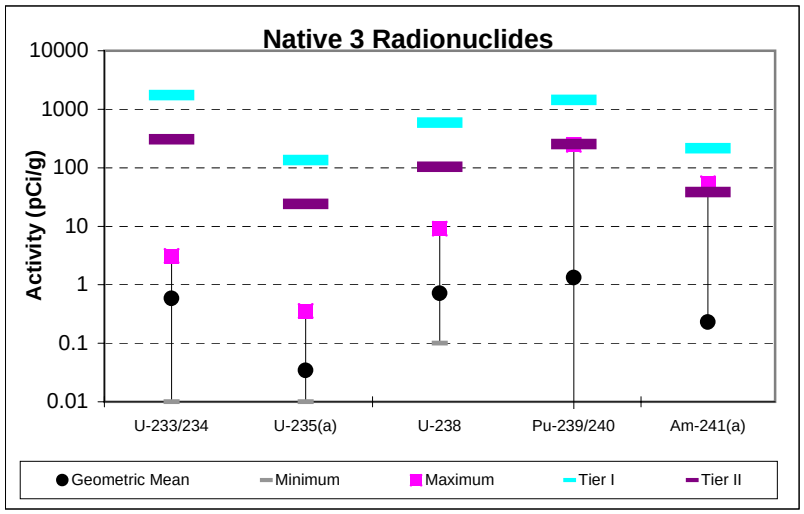
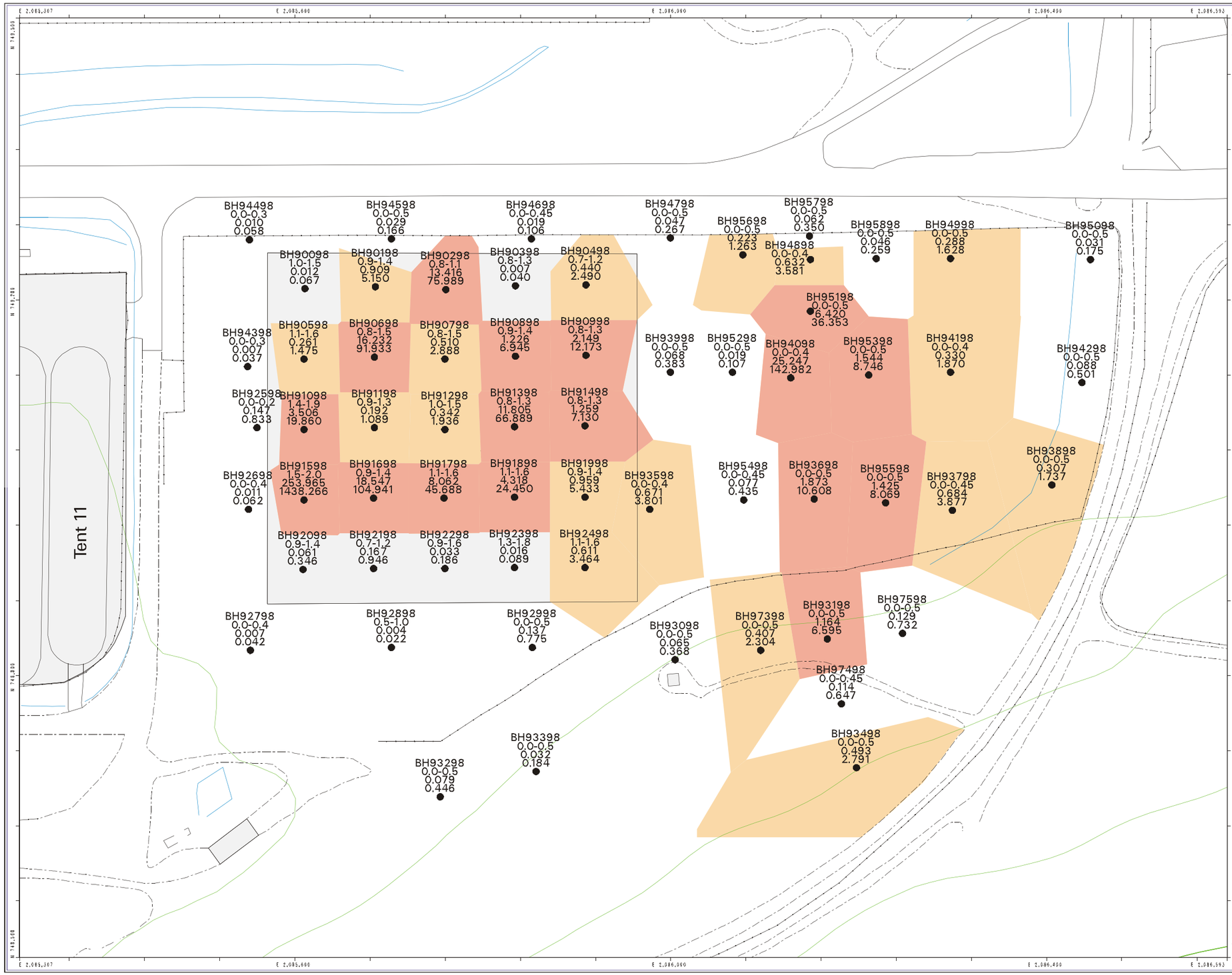






(a) Denotes median used instead of geometric mean

Figure 4-5. Range of Radionuclide Activities in Native 1, Native 2, and Native 3 Soils Horizons.



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

RSAL Exceedances in Native 1 Soil Horizon

Figure 4-6

EXPLANATION

Boreholes locations

- Location
  Sample Depth (ft.)
  Tier I Sum of Ratio
  Tier II Sum of Ratio
- Exceed Tier I
- Exceed Tier II

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1290
1 inch represents approximately 108 feet

25 0 50 100ft

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Colorado Central Zone
Datum: NAD27

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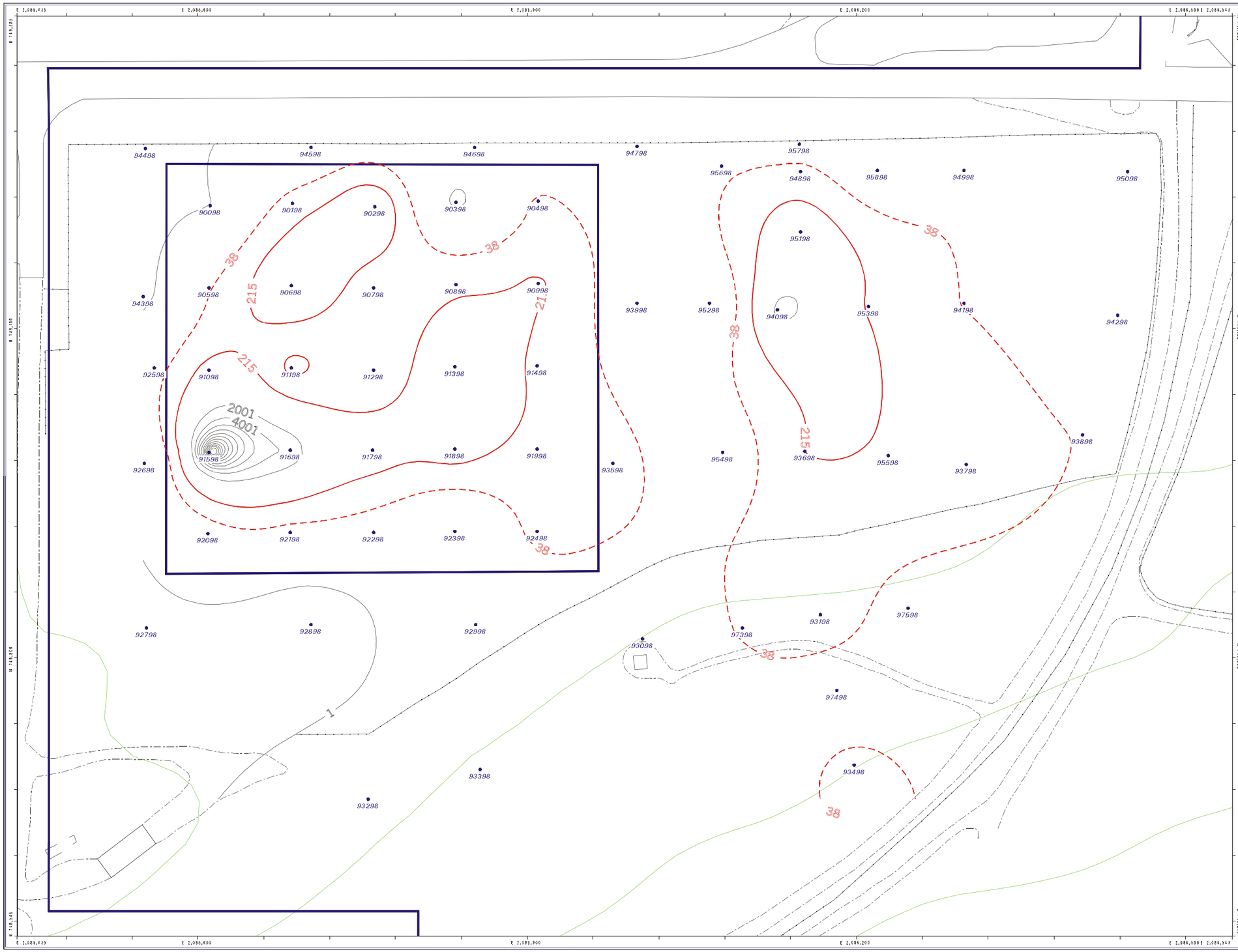

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Am-241 in Native 1 Soil Horizon

Figure 4-7

EXPLANATION

- Am-241 Levels and Isoactivity Contour (Contour Interval = 2000 pCi/g)
- Extent of RFCA Tier I Exceedances (215 pCi/g)
- Extent of RFCA Tier II Exceedances (38 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared for: KH

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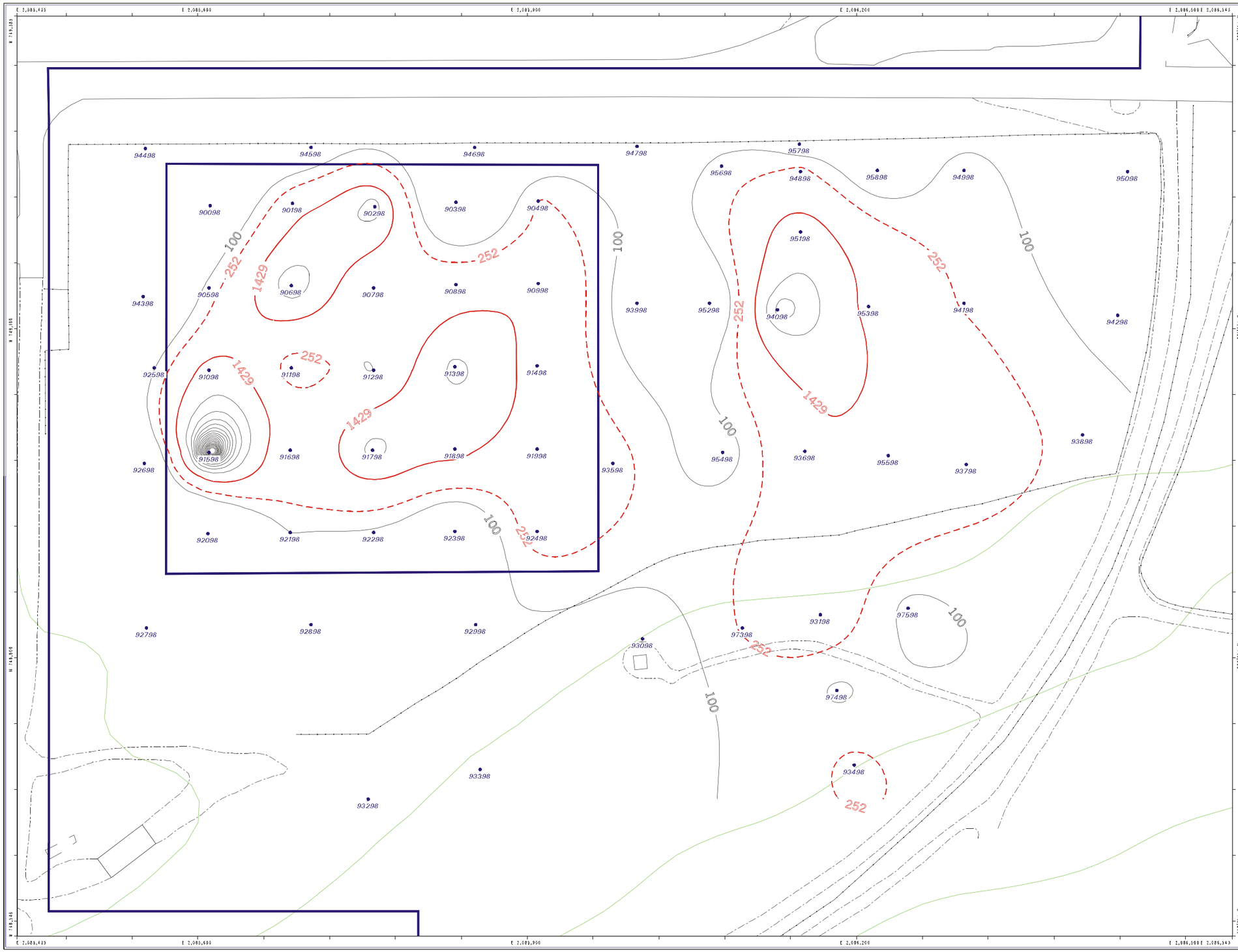

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Pu-239/240 in Native 1 Soil Horizon

Figure 4-8

EXPLANATION

- Pu-239/240 Levels and Isoactivity Contour (Contour Interval = 10,000 pCi/g)
- Extent of RFCA Tier I Exceedances (1429 pCi/g)
- Extent of RFCA Tier II Exceedances (252 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

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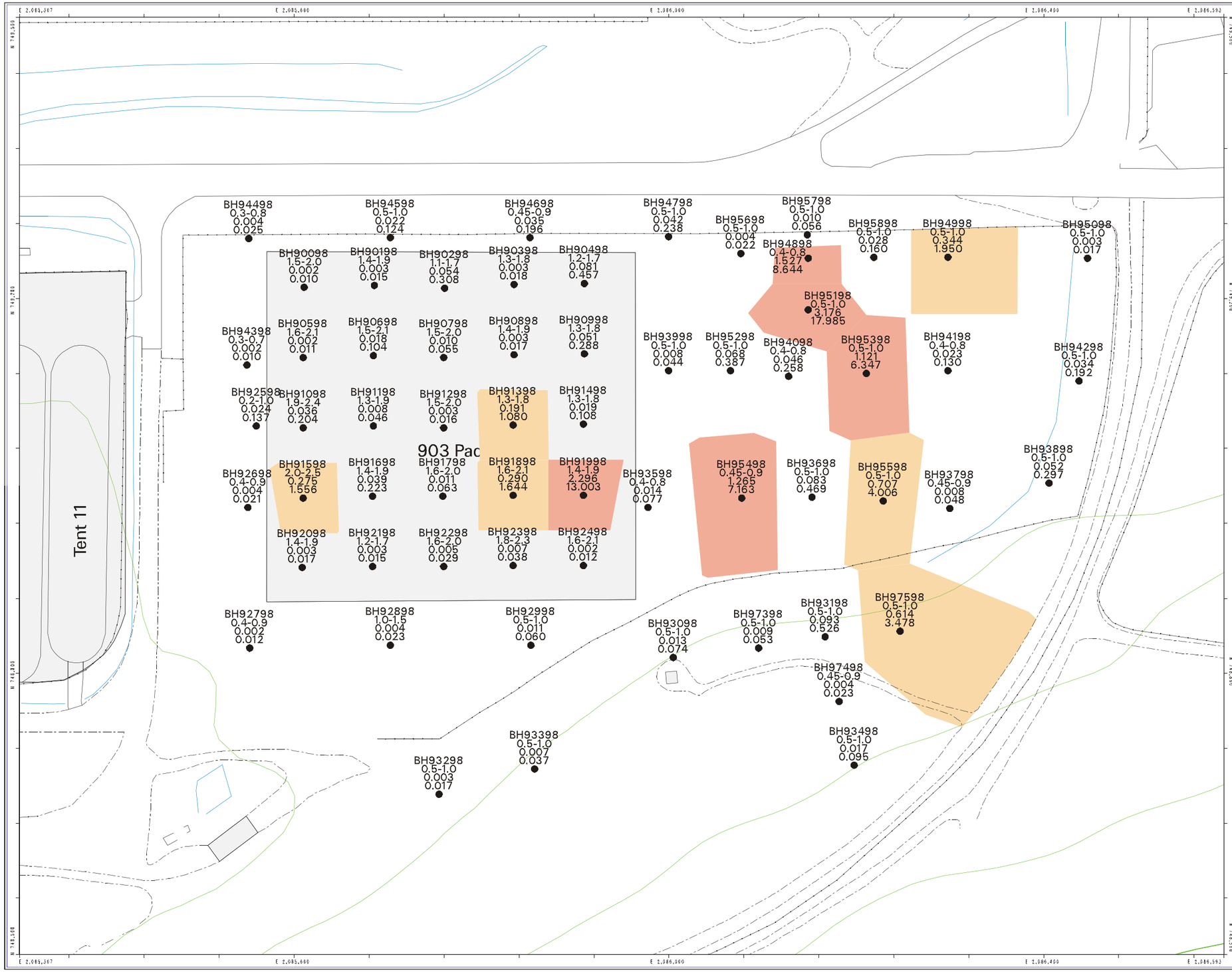

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

RSAL Exceedances in Native 2 Soil Horizon

Figure 4-9

EXPLANATION

Boreholes locations

- Location
- Sample Depth (ft.)
- Tier I Sum of Ratio
- Tier II Sum of Ratio

Exceed Tier I

Exceed Tier II

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1290
1 inch represents approximately 108 feet

25 0 50 100ft

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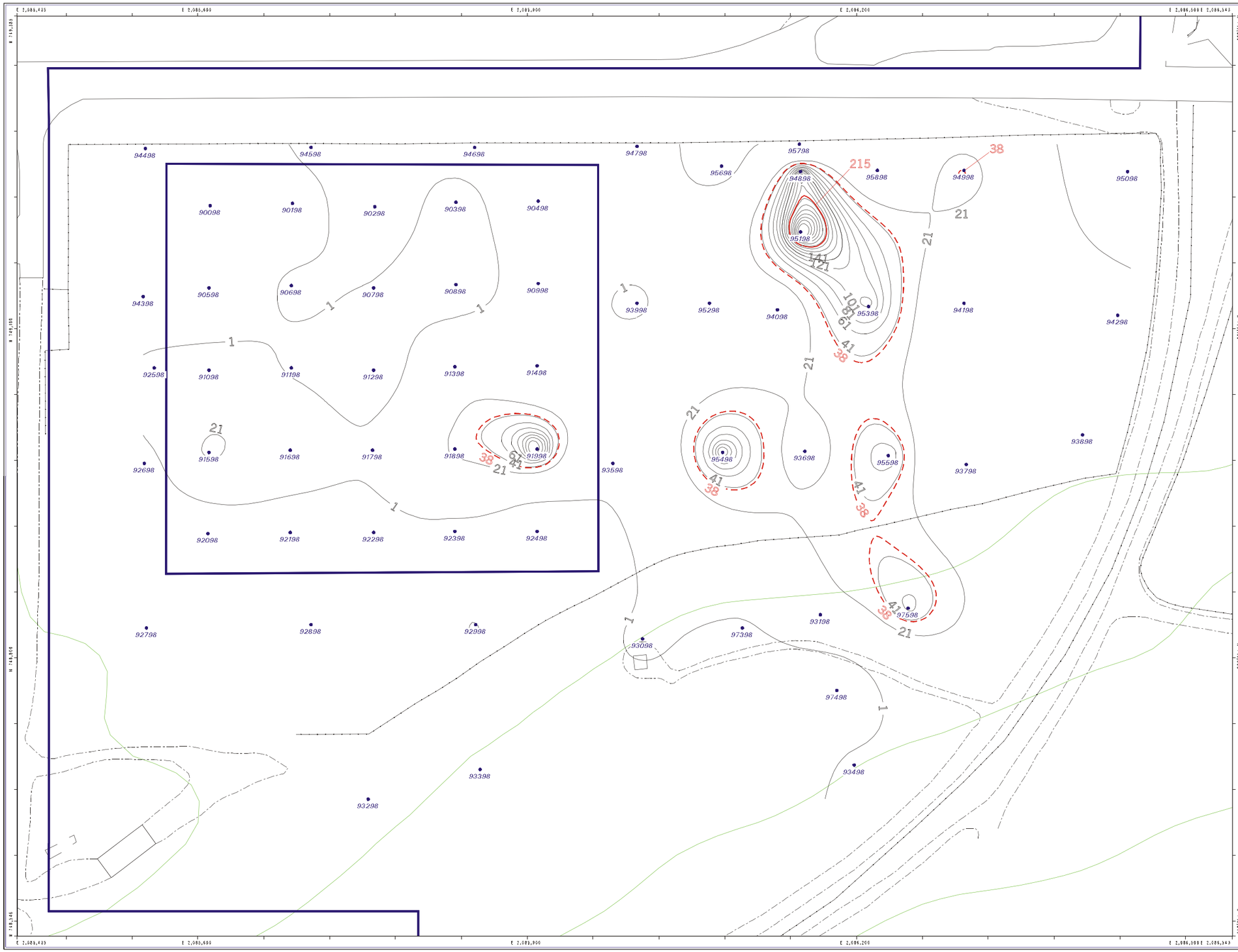

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Am-241 in Native 2 Soil Horizon

Figure 4-10

EXPLANATION

- Am-241 Levels and Isoactivity Contour (Contour Interval = 20 pCi/g)
- Extent of RFCA Tier I Exceedances (215 pCi/g)
- Extent of RFCA Tier II Exceedances (38 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

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Colorado Central Zone
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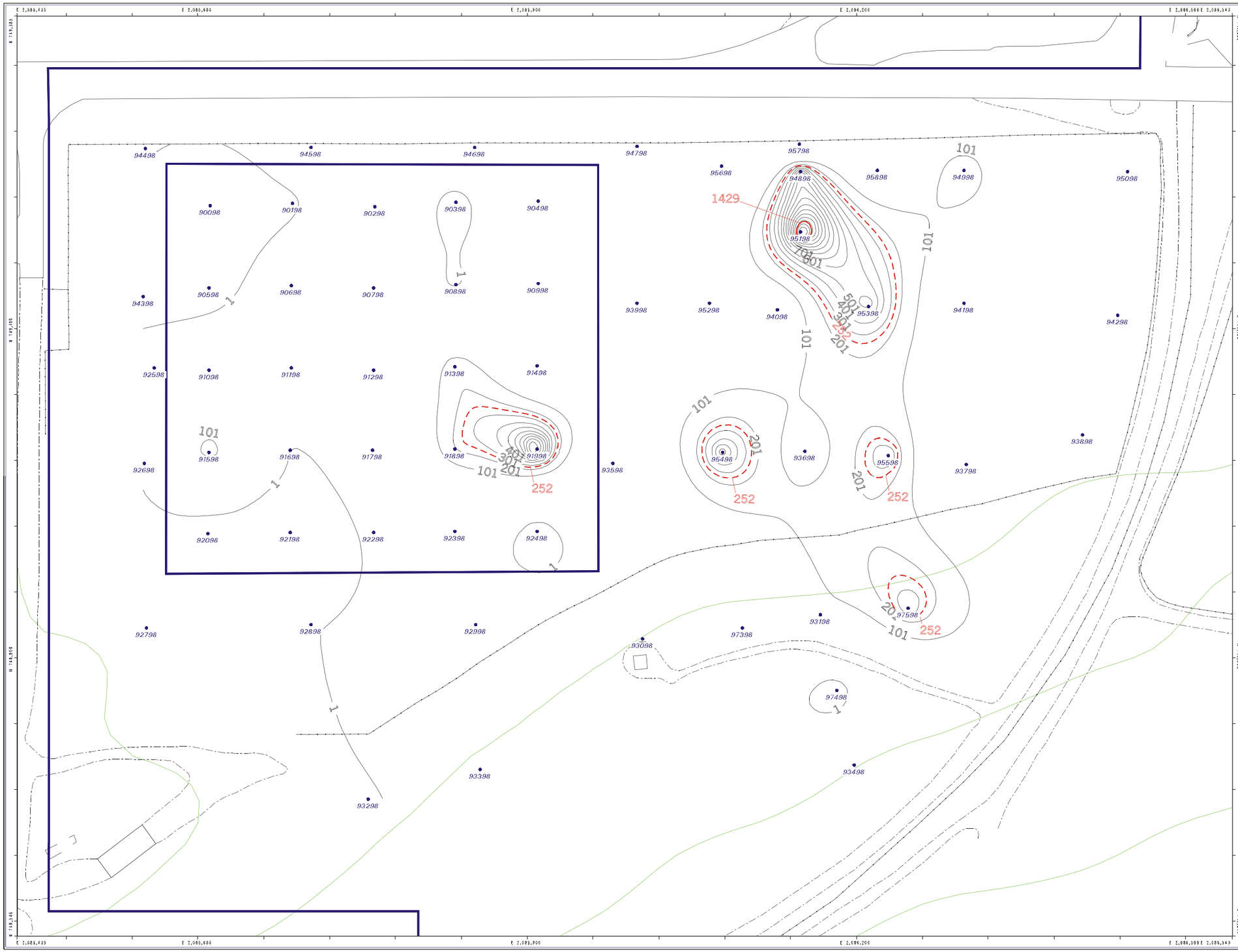

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Pu-239/240 in Native 2 Soil Horizon

Figure 4-11

EXPLANATION

- Pu-239/240 Levels and Isoactivity Contour (Contour Interval = 100 pCi/g)
- Extent of RFCA Tier I Exceedances (1429 pCi/g)
- Extent of RFCA Tier II Exceedances (252 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

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Datum: NAD27

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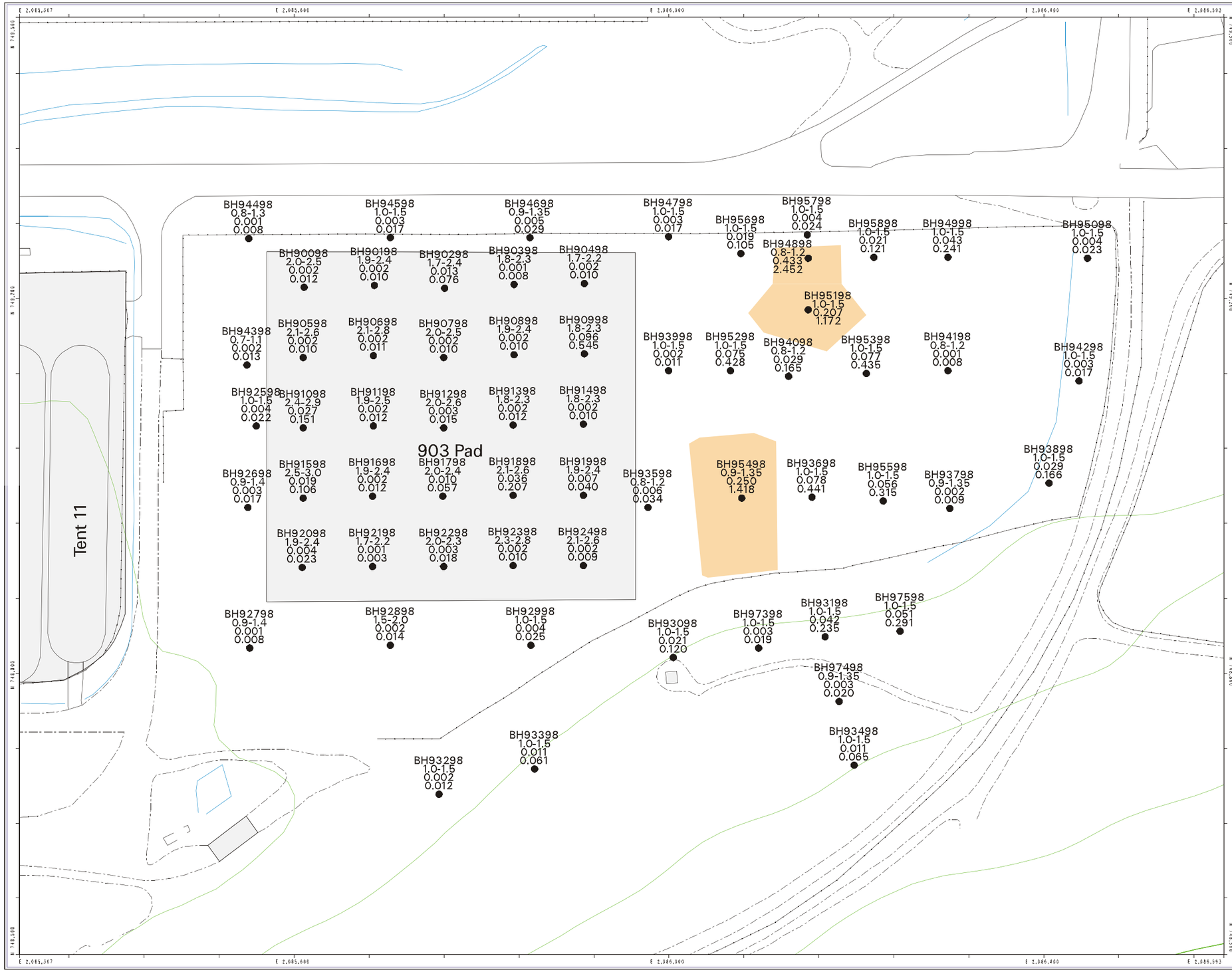

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

RSAL Exceedances in Native 3 Soil Horizon

Figure 4-12

EXPLANATION

Boreholes locations

- Location
- Sample Depth (ft.)
- Tier I Sum of Ratio
- Tier II Sum of Ratio

Exceed Tier I

Exceed Tier II

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1:25
topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post processing performed by MK, Winter 1997.

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Scale = 1 : 1290
1 inch represents approximately 108 feet

25 0 50 100ft

State Plane Coordinate Projection
Colorado Central Zone
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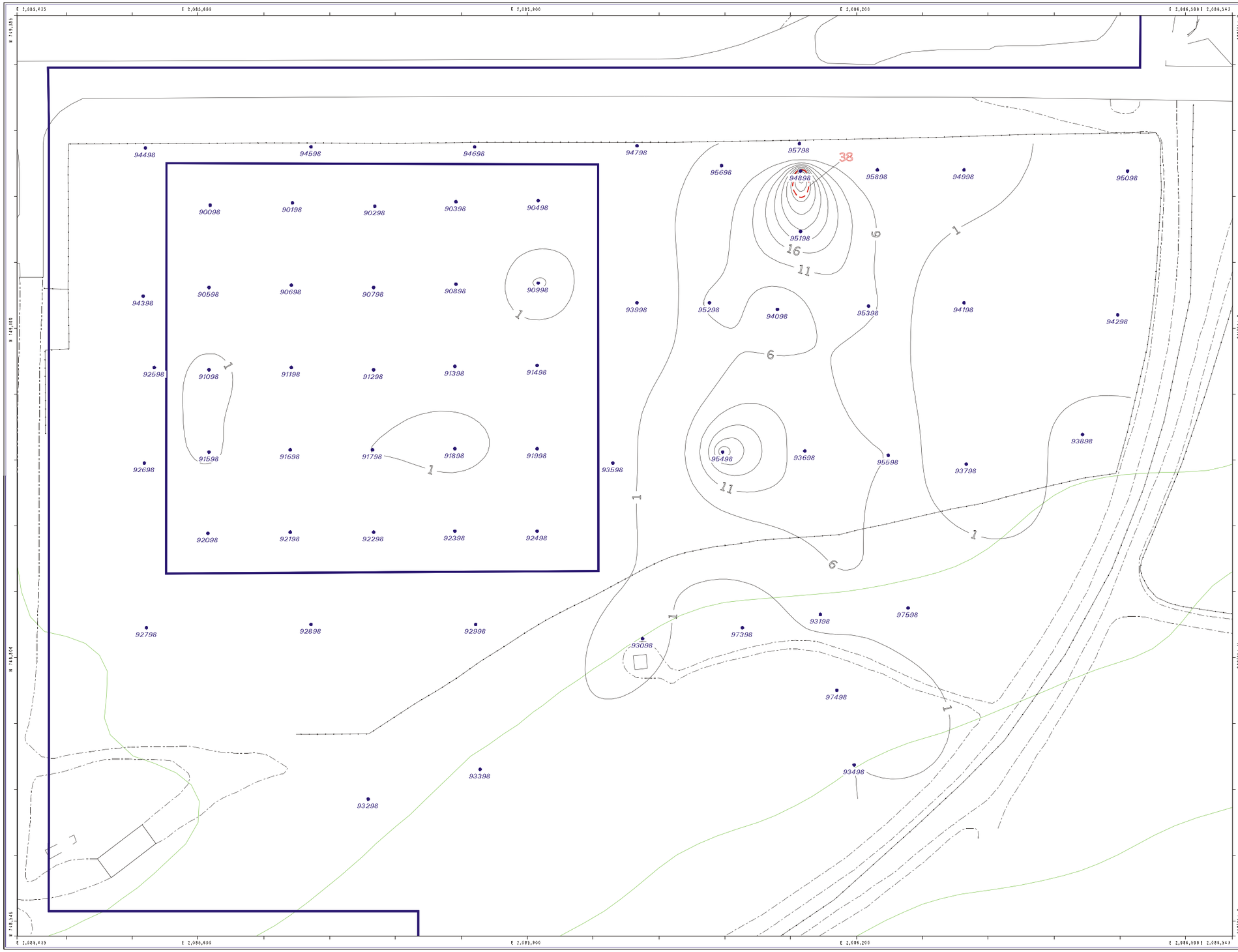

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Am-241 in Native 3 Soil Horizon

Figure 4-13

EXPLANATION

- Am-241 Levels and Isoactivity Contour (Contour Interval = 5 pCi/g)
- Extent of RFCA Tier I Exceedances (215 pCi/g)
- Extent of RFCA Tier II Exceedances (38 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KH

MAP ID: 99-0408

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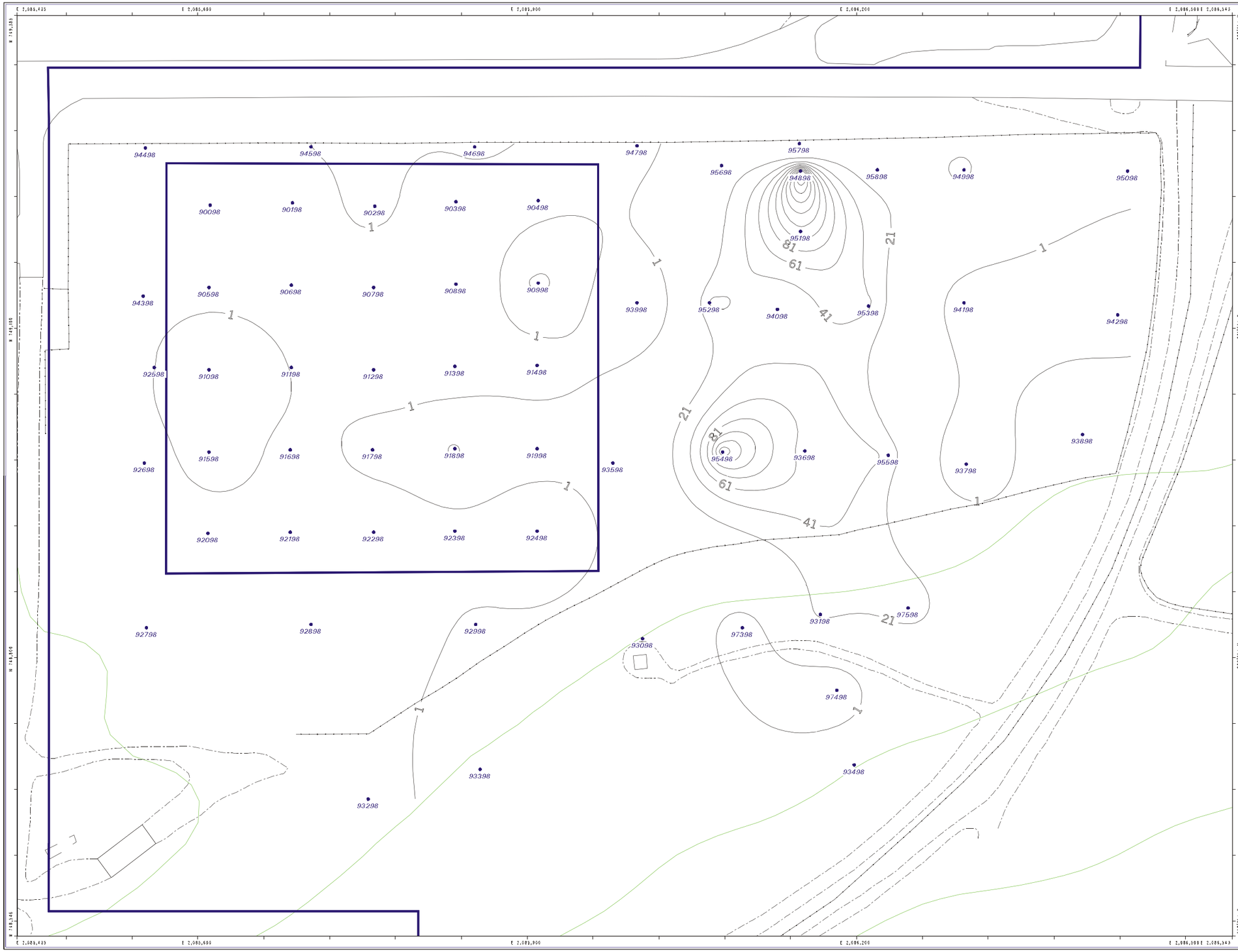

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Distribution of Pu-239/240 in Native 3 Soil Horizon

Figure 4-14

EXPLANATION

- Pu-239/240 Levels and Isoactivity Contour (Contour Interval = 20 pCi/g)
- Extent of RFCA Tier I Exceedances (1429 pCi/g)
- Extent of RFCA Tier II Exceedances (252 pCi/g)
- Investigation Area
- Borehole Locations

Standard Map Features

- Buildings and other structures
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1080
1 inch represents 90 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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Prepared for: KH

MAP ID: 99-0408

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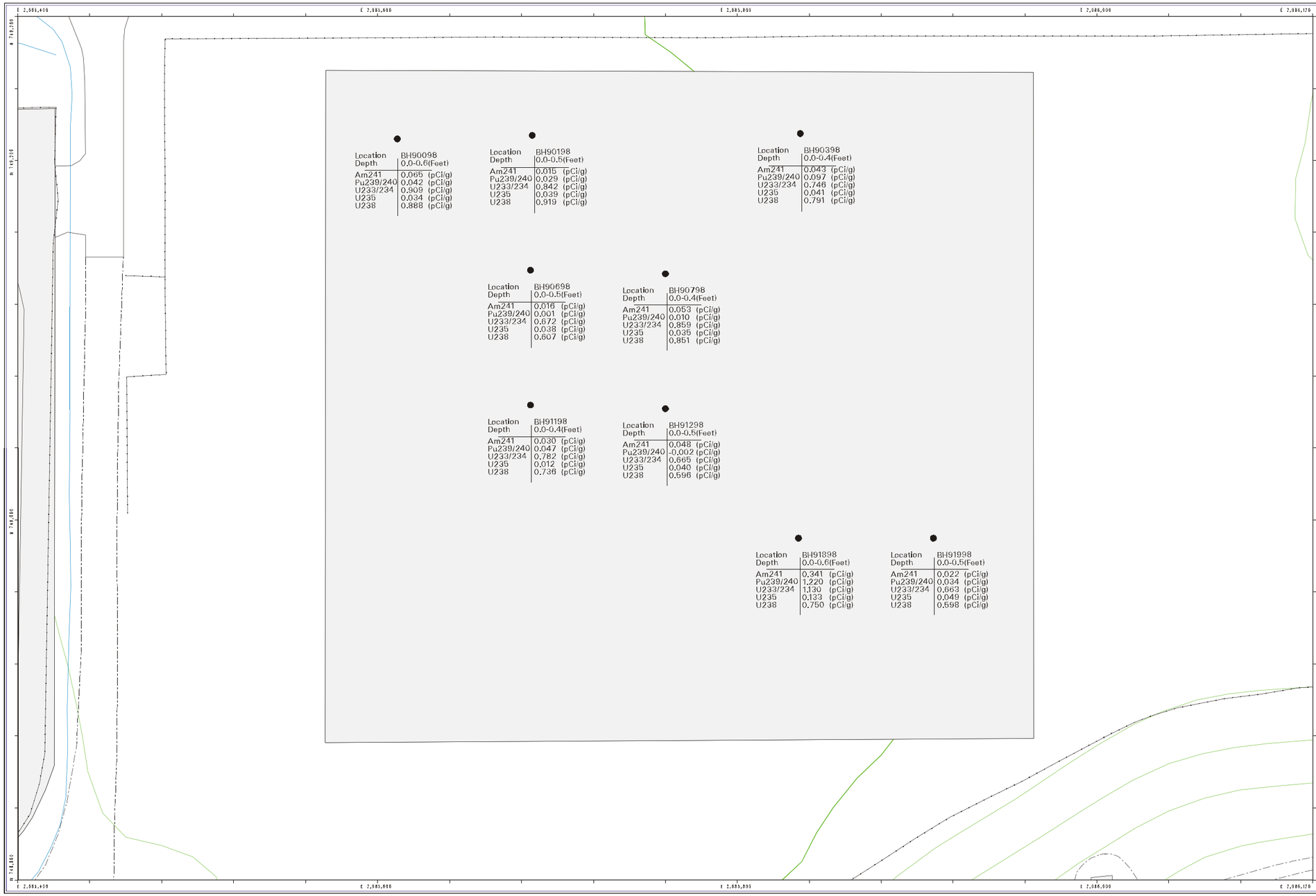

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Radionuclide Distribution in Asphalt

Figure 4-15

EXPLANATION

Boreholes locations

- Location
  Sample Depth (ft.)
  AM241 (pCi/g)
  PU239/240 (pCi/g)
  U233/234 (pCi/g)
  U235 (pCi/g)
  U238 (pCi/g)

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, 1/14, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 700
1 inch represents approximately 58 feet

15 0 30 60 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared for:

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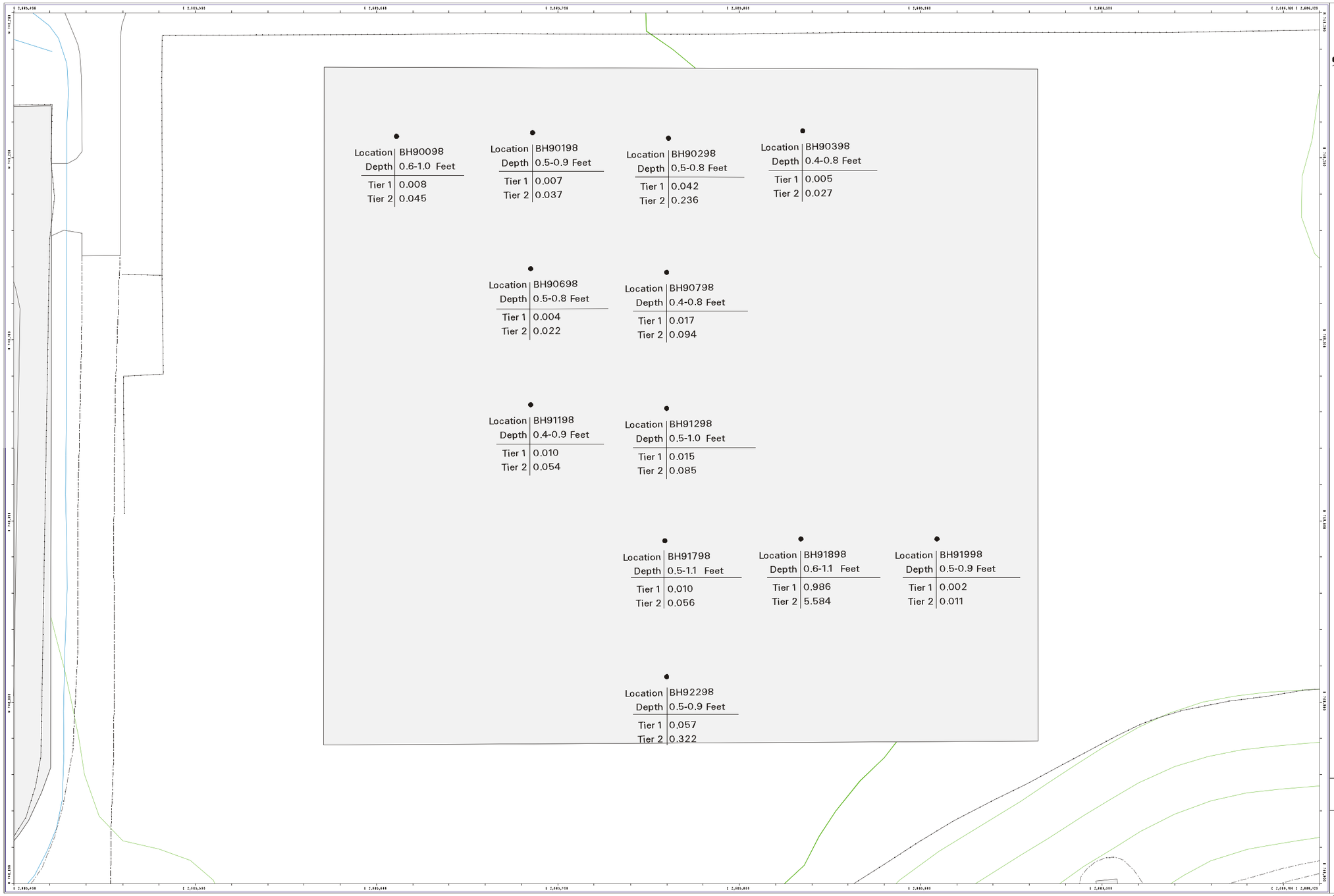

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

RSAL Exceedances in Artificial Fill Beneath the 903 Pad

Figure 4-16

EXPLANATION

Boreholes locations

- Location
  Sample Depth (ft.)
  Tier I Sum of Ratio
  Tier II Sum of Ratio

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1:95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
DEM post processing performed by MK, Winter 1997.

N

Scale = 1 : 660
1 inch represents 55 feet

10 0 20 40 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared for:

MAP ID: 99-0409

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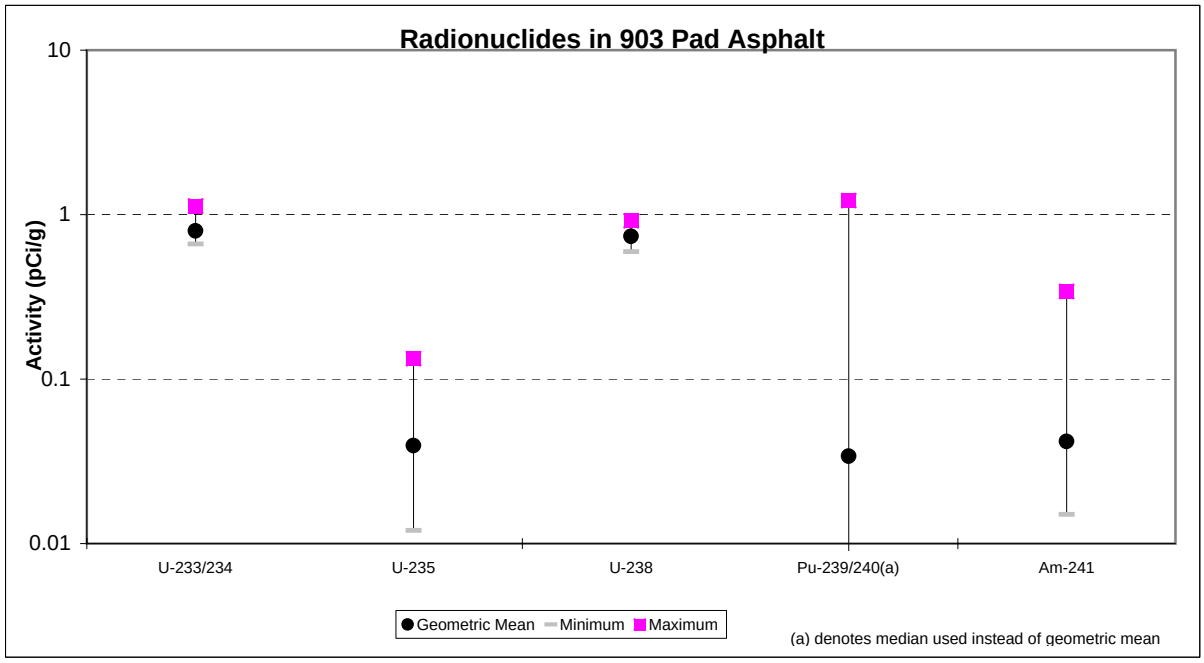


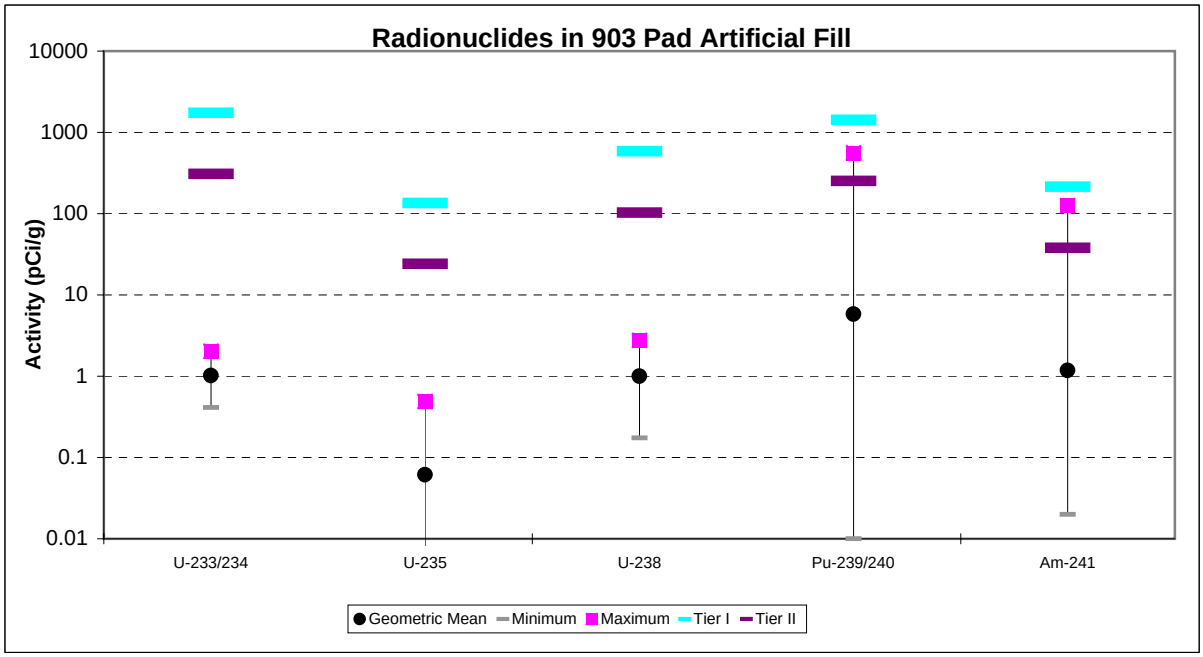
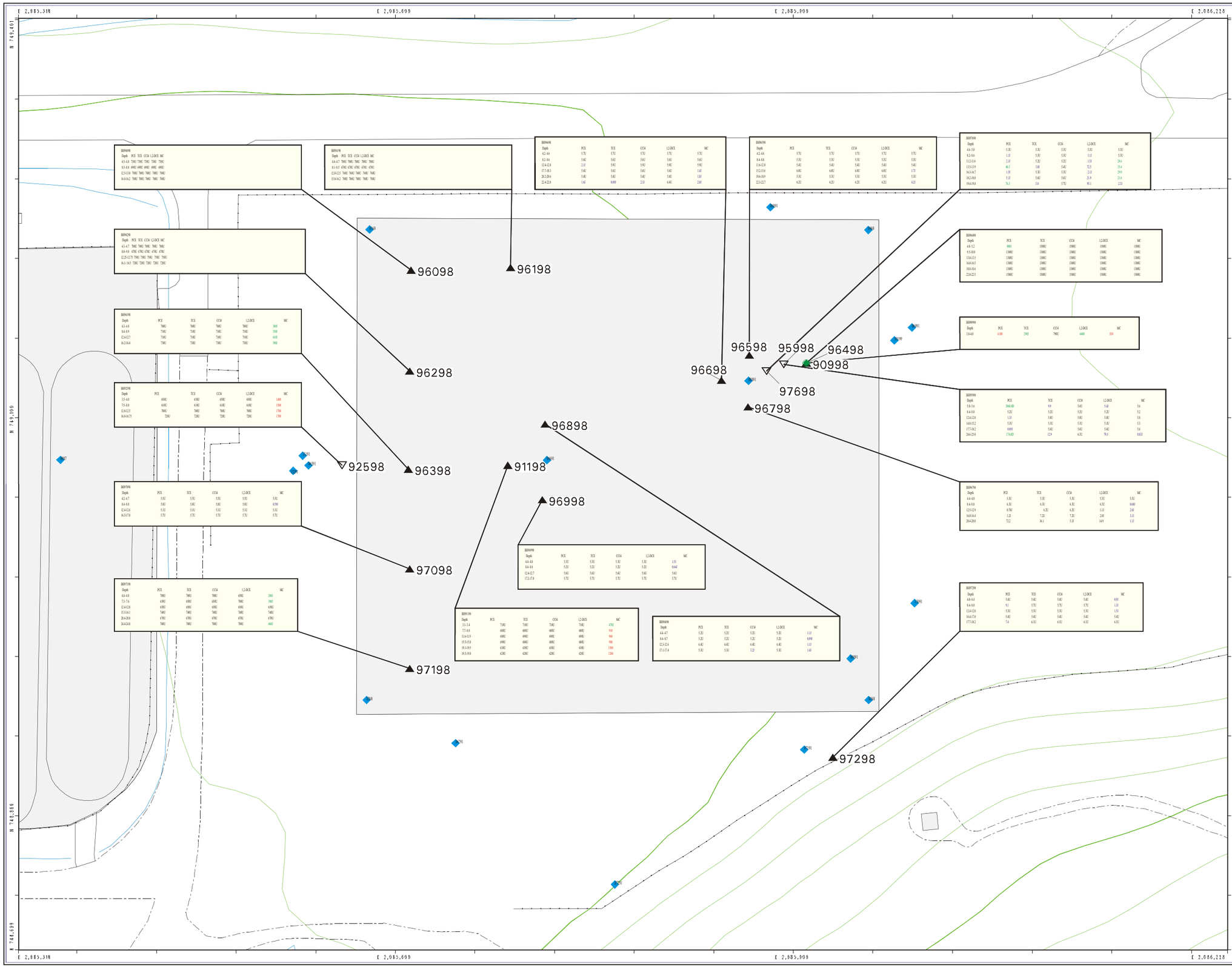


Figure 4-17. Range of Radionuclide Activities in Asphalt and Artificial Fill



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

VOC Distribution in Soil

Figure 4-18

EXPLANATION

- VOC Boreholes, Original
- VOC Boreholes, Stepout
- Radiological Borehole
- Borehole location
  BoreHole PCE TCE CCL4 1,2-DCE
  Sample Depth Results in Feet
  VOC Compound Results in ug/kg
- Groundwater Well

NOTE:
VOC detections in blue
Proposed Tier I Exceedance in red
Proposed Tier II Exceedance in green
PCE = Tetrachloroethene
TCE = Trichloroethene
CCL4 = Carbon Tetrachloride
1,2-DCE = 1,2-Cis-Dichloroethylene
MC = Methylene Chloride

U = Undetected, Contract Required Quantitative Limit
J = Associated Value is an Estimated Quantity
D = Dilution

Standard Map Features

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- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

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Scale = 1 : 830
1 inch represents approximately 69 feet

25 0 50 100ft

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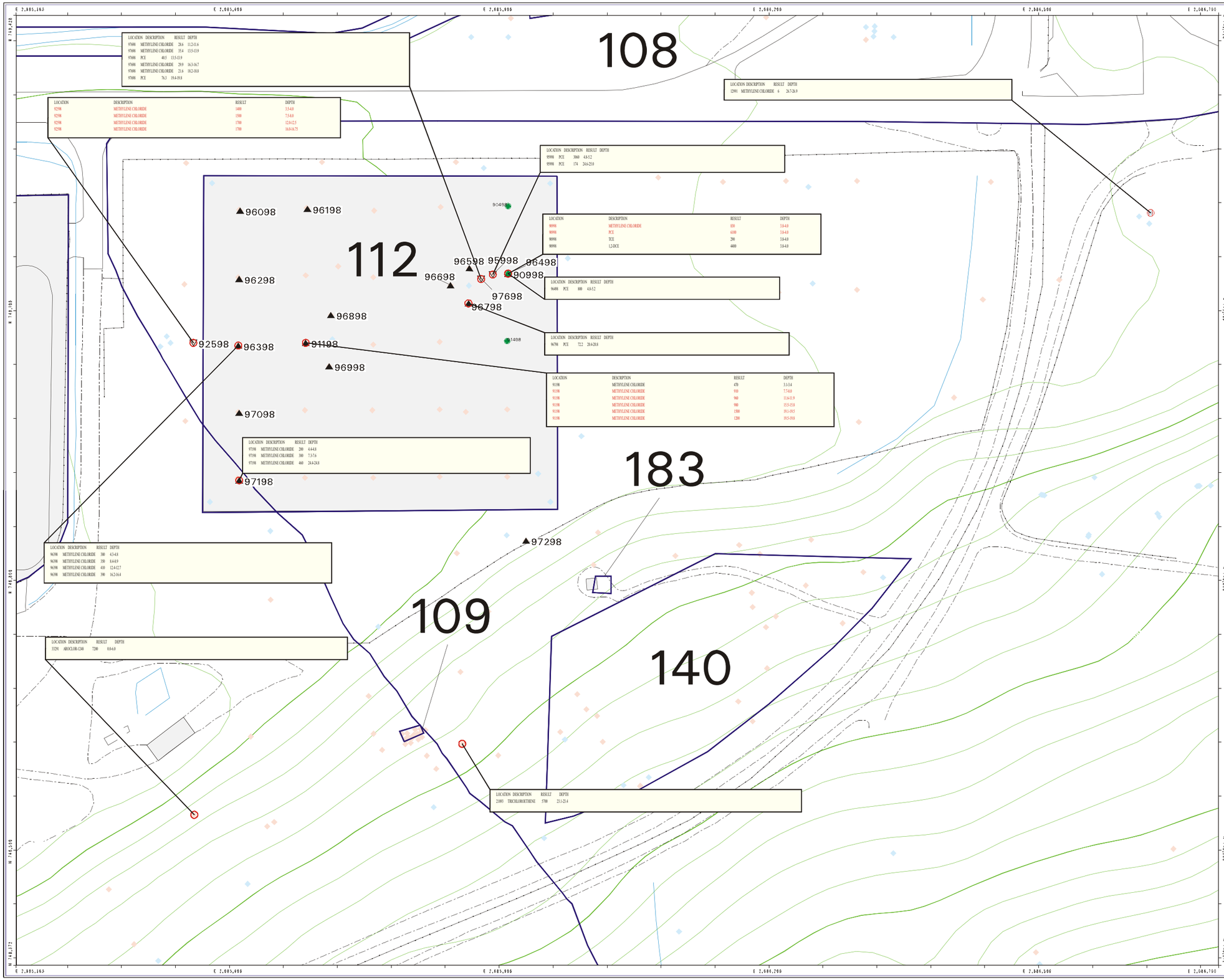

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Extent of Tier I and Tier II Subsurface SAL Contamination
Figure 4-19

EXPLANATION

All Wells and Borings

- Monitoring Wells
- Soil Boreholes

Historical Soil Samples

- Monitoring Wells
- Soil Boreholes

903 Pad VOC Boreholes

- VOC Boreholes, Original
- VOC Boreholes, Stepout
- Radiological Borehole

Individual Hazardous Substance Sites

- Former OU2, Buffer Zone and Industrial Area IHSS

Standard Map Features

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- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

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N

Scale = 1 : 1260
1 inch represents 105 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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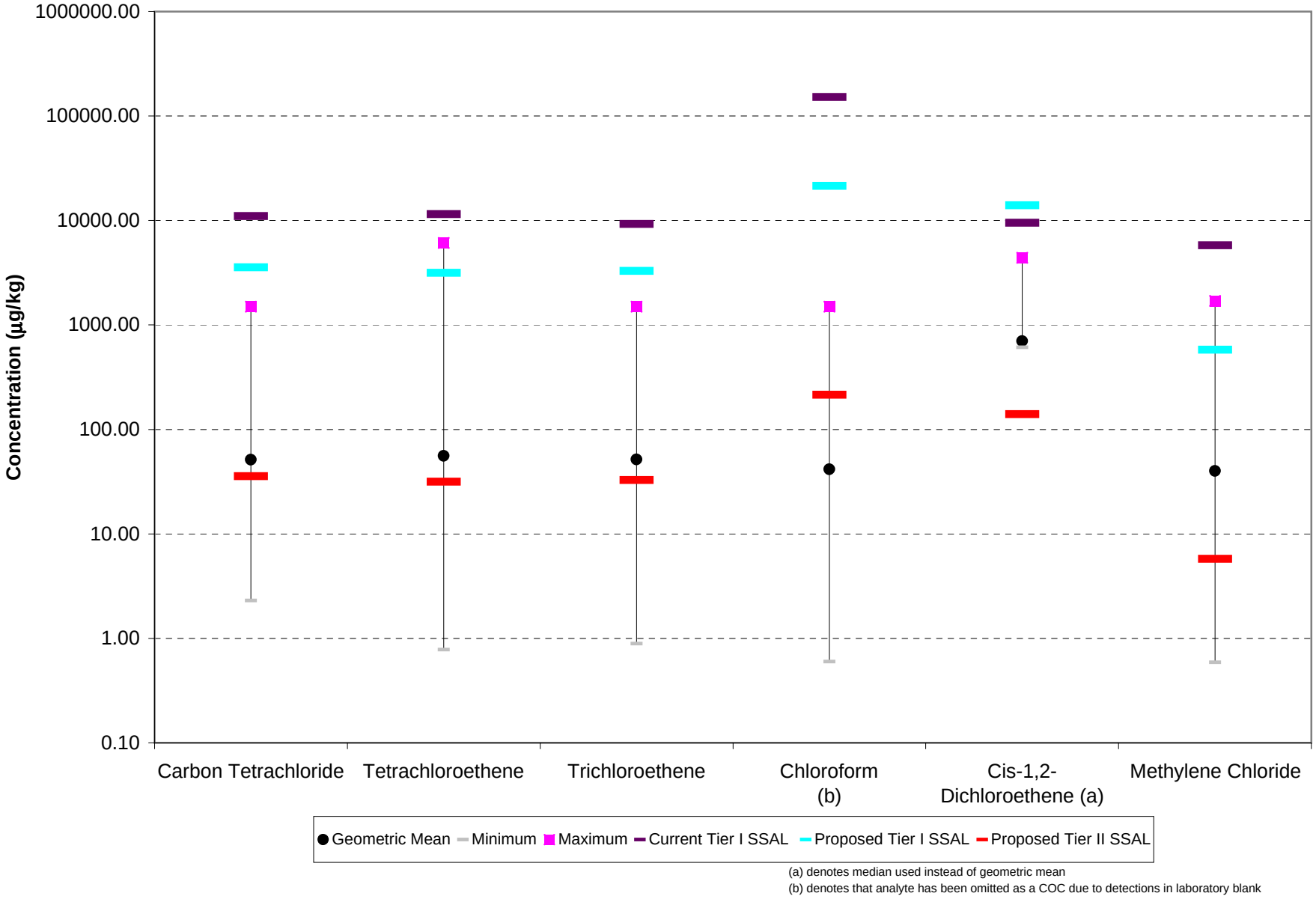


Figure 4-20. Range of VOC Concentrations in Subsurface Soil

5.0 CONTAMINATED MEDIA VOLUME ESTIMATES

Volume estimates of radiological and VOC contaminated surface and subsurface soil are based on the areal and vertical extent of contamination above Tier I and Tier II RSALs and proposed SSALs. An ArcInfo, version 7.2.2, Thiessen polygon command (ESRI, 1999) was used to determine areas exceeding action levels for subsequent in-place volume calculations. Remedial alternatives will be evaluated in the IM/IRA Decision Document based on these volume estimates. In-place volume estimates for the 903 Pad asphalt and artificial fill are also presented.

5.1 903 PAD ASPHALT AND ARTIFICIAL FILL VOLUME ESTIMATES

Characterization data for the asphalt comprising the 903 Pad were collected only for waste characterization profiling. A comparison to these data to Tier I or Tier II RSALs is not relevant because RSALs are derived for soil cleanup. The estimated in-place volume of asphalt is 2,743 yd^3. The estimated in-place volume of artificial fill is 2,743 yd^3. The amount of radiologically contaminated artificial fill, relative to Tier II RSALs, beneath the 903 Pad is estimated at 104 yd^3. The 104 yd^3 estimate is based on a 75 ft by 75 ft area surrounding boring 91898 and a 6 inch thickness of artificial fill. Table 5-1 summarizes the estimated areal extent, depth, and in-place volumes of asphalt and artificial fill for the 903 Pad.

Table 5-1 Summary of 903 Pad Asphalt and Artificial Fill Volumes

903 Pad	Depth (ft)	Area (ft^2)	Volume[1] (ft^3)	Volume[1] (yd^3)	Volume[1] (m^3)
Asphalt	0.5	148,104	74,052	2,743	2,097
Artificial Fill less than Tier II RSALs	0.5	142,479	71,239	2,639	2,017
Artificial Fill greater than Tier II RSALs	0.5	5,625	2,813	104	80
Total	-------	**296,208**	**148,104**	**5,485**	**4,194**

[1]Volume represents materials in-place

5.2 TIER I RSAL EXCEEDANCE SOIL VOLUME ESTMATES

A composite map of the areal extent of Tier I RSAL exceedances in soil is presented in Figure 5-1. As shown, soil with radionuclides exceeding the Tier I RSALs is located beneath the 903 Pad, east of the 903 Pad in the Lip Area, and sporadically in the southern portion of the Lip Area and western portion of the Americium Zone. Table 5-2 summarizes the estimated areal extent, depth, and in-place volumes of soils exceeding Tier I RSALs by IHSS. The areal extent of Native 1 radiologically contaminated surface soil (relative to Tier I RSALs) is 120,359 ft^2. Depth of contamination varies from 0 to 6 inches to 0 to 12 inches throughout the investigation area. Based on the areal and vertical extent of Tier I RSAL exceedances, the total volume of in-place radiologically contaminated soil is 2,925 yd^3. The in-place volumes of contaminated soil by IHSS are as follows: 1,268 yd^3 for the 903 Pad; 1,580 yd^3 for the Lip Area; and 76 yd^3 for the Americium Zone.

Table 5-2 Summary of Radiologically Contaminated Soil Volumes-Tier I RSAL Exceedances

903 Pad	Depth (ft)	Area (ft^2)	Volume[1] (ft^3)	Volume[1] (yd^3)
Native 1	0.5	62,953	31,477	1,166
Native 2	0.5	5,532	2,766	102
Total	---------	----------	**34,243**	**1,268**
Lip Area				
Native 1	0.5	53,295	26,648	987
Native 2	0.5	32,044	16,022	593
Total	---------	----------	**42,670**	**1,580**
Americium Zone				
Native 1	0.5	4,111	**2,056**	**76**
Grand Total	---------	----------	**78,473**	**2,925**

[1] Volume represents materials in-place

5.3 TIER II RSAL EXCEEDANCE SOIL VOLUME ESTIMATES

A composite map of the areal extent of Tier II RSAL exceedances in soil is presented in Figure 5-2. As expected, contamination above the Tier II RSALs is much more extensive than that of the Tier I RSAL exceedances. In general, Tier II RSAL exceedances encompass most of the 903

Pad, the Lip Area, and the Americium Zone. Tier II RSAL exceedances in two portions of the Lip Area extend down to the Native 3 soil horizon, a depth of 1.5 feet. Figure 5-2 shows the areal extent of the Tier II RSAL exceedances for the Native 1 (0 to 6-inch), Native 2 (6 to 12-inch), and Native 3 (12 to 18-inch) soil horizons. Table 5-3 summarizes the estimated areal extent, depth, and in-place volumes of soils exceeding Tier II RSALs by IHSS.

The areal extent of Native 1 radiologically contaminated surface soil (relative to Tier II RSALs) is 654,793 ft^2. Depth of contamination varies from 0 to 6 inches to 0 to 18 inches within the investigation area. Based on the areal and vertical extent of Tier II RSAL exceedances, the total volume of in-place radiologically contaminated soil is 14,307 yd^3. A depth of 6 inches was used to estimate volumes of soil in the Americium Zone. Radiologically contaminated soil volumes based on Tier II RSAL exceedances are summarized in Table 5-3. The in-place volumes of contaminated soil by IHSS are as follows: 2,471 yd^3 for the 903 Pad; 4,811 yd^3 for the Lip Area; and 7,025 yd^3 for the Americium Zone.

Table 5-3 Summary of Radiologically Contaminated Soil Volumes-Tier II RSAL Exceedances

903 Pad	Depth (ft)	Area (ft^2)	Volume[1] (ft^3)	Volume[1](yd^3)
Native 1	0.5	111,676	55,838	2,068
Native 2	0.5	21,738	10,869	403
Total	---------	**----------**	**66,707**	**2,471**
Lip Area				
Native 1	0.5	163,784	81,892	3,033
Native 2	0.5	74,065	37,033	1,372
Native 3	0.5	21,941	10,971	406
Total	---------	**----------**	**129,896**	**4,811**
Americium Zone				
Native 1	0.5	**379,333**	**189,667**	**7,025**
Grand Total	---------	**----------**	**386,270**	**14,307**

[1] Volume represents materials in-place

5.4 SSAL EXCEEDANCE SOIL VOLUME ESTIMATES

Organic contaminants of concern (methylene chloride, CCl_4, PCE, 1,2-DCE, TCE, and Aroclor-1248) did not exceed the current Tier I SSALs. However, as discussed in Section 4.3, PCE, TCE, and methylene chloride exceed the proposed Tier I SSAL in borings 90998, 91198, 21893 and 92598 (Figures 4-18 and 4-19). Tier I SSAL exceedances below the water table were excluded from further consideration. For example, TCE and methylene chloride were detected above the Tier I SSALs at borings 21893 and 12991, respectively (Figure 4-19) but were observed below the water table (depth to water varies from 10 to 20 feet bgs in the Lip Area). VOC contamination below the water table will be addressed under the RFETS sitewide ground water program.

Soil concentrations between proposed Tier I and Tier II SSALs occur at borings 33291, 21893, 96398, 97198, 92598, 97698, 95998, 90998, 96498, 96798, 91198, and 12991. Methylene chloride is the most ubiquitous of the organic compounds, occurring at 7 boring locations at or near the 903 Pad followed by PCE, which was observed in five borings, and 1,2-DCE which exceeded the proposed Tier II SSAL in boring 90998. The depth of contamination between proposed Tier I and Tier II SSALs varies from 0 to 6 feet bgs at boring 33291 to 1 to 19.8 feet at boring 97698.

At the 903 Pad, the depth of organic concentrations between proposed Tier I and Tier II SSALs is assumed to extend from the natural soil surface below the top of the asphalt to the deepest extent of observed contamination above the water table. This is a conservative assumption given that organic samples were not collected above the Native 1 soil horizon. The areal extent of contamination was bounded one-half the distance between adjacent borings where VOC results were below their respective SSALs, and by the edge of the 903 Pad to the east. Several proposed Tier II SSAL exceedances were observed below the water table (average depth to water is 19 feet bgs) at boreholes 95998, 96798, and 97698. Similar to Tier I SSAL exceedances, VOC contamination below the water table will be addressed under the sitewide groundwater program.

5.4.1 Tier I SSAL Exceedance Soil Volume Estimates

A composite map showing the areal extent of contamination as defined by the proposed Tier I SSALs is presented in Figure 5-3. The depth of VOC contamination varies beneath the 903 Pad. For example, at boring 92598, the depth of contamination occurs between 0 and 16.75 feet bgs, at boring 91198 contamination extends from 7.75 to the water table (19.0 feet bgs), and from 1.0 to 4 feet bgs at boring 90998. Based on the areal and vertical extent of the proposed Tier I SSAL exceedances, the total in-place volume of contaminated soil is 4,237 yd^3 (Table 5-4). This amount also includes 174 yd^3 of radiologically contaminated soil relative to proposed Tier I and Tier II RSAL exceedances (Figures 5-1 and 5-2).

Table 5-4 Summary of Radiologically Contaminated Soil Volumes – SSAL Exceedances

Area/Material	Volume Estimate (yd^3)
Soil > Proposed Tier I SSALs	
Soil Mixed With Radionuclides: > Tier I RSALs	93
Soil Mixed With Radionuclides: > Tier II RSALs	81
Soil > Tier I SSALs	4,063
Total	**4,237**
Soil Between Proposed Tier I and Tier II SSALs	
Soil Mixed With Radionuclides: > Tier I RSALs	143
Soil > Tier II SSALs	6,670
Total	**6,813**

[1] Volume represents materials in-place volume.

5.4.2 Tier II SSAL Exceedance Soil Volume Estimates

A composite map showing the areal extent of contamination as defined by the proposed Tier II SSALs is presented in Figure 5-3. Soil concentrations between proposed Tier I and Tier II SSALs occur at borings 97698, 95998,33291, and 97198. The depth of contamination between proposed Tier I and Tier II SSALs varies from 0 to 6 feet bgs at boring 33291 to 1 foot bgs to the water table (19.0 feet bgs) near boring 97698.

Based on the aerial extent and depth of contamination, the amount of soil characterized between proposed Tier I and Tier II SSALs is 6,813 yd^3 (Table 5-4). This amount also includes 143 yd^3 of radiologically contaminated soil above Tier 1 RSALs (Figure 5-1).

5.5 RSAL AND SSAL EXCEEDANCE SOIL VOLUME ESTIMATES

Four areas within the 903 Pad contain surface soil with elevated levels of both radionuclides (RSALs) and VOCs (SSALs). Soil exceeding proposed SSALs occur in the areas shown in Figure 5-3. Soil exceeding Tier I and Tier II RSALs are provided in Figures 5-1 and 5-2, respectively. Comparing these figures with Figure 5-3 shows that there are areas where both RSALs and SSALs exceedances overlap. Soil containing both RSAL and SSAL exceedances occurs to a depth of 6 inches in these areas. An estimated total of 93 yd^3 ([5,017 ft^2 x 0.5 ft]/27 ft^3/yd^3) of soil exceed both Tier I RSALs and proposed Tier I SSALs at boring 90998.
At boring 91198, an estimated total of 81 yd^3 ([4,400 ft^2 x 0.5 ft]/27 ft^3/yd^3) of soils exceed both proposed Tier I SSALs and Tier II RSALs (Table 5-4).

Proposed Tier II SSAL exceedances in natural soils occur to depths of 19.8 feet near boring 97698 and 16.4 feet at boring 96398. Tier I (and consequently Tier II) RSAL exceedances in natural soils are present to a depth of 6 inches near these borings. Therefore, an estimated total of 143 yd^3 ([7,718 ft^2 x 0.5 ft]/27 ft^3/yd^3) of soils exceed both Tier I RSALs and proposed Tier II SSALs (Table 5-4).

5.6 SSAL EXCEEDANCE SOIL VOLUME ESTIMATES (NON-RADIOLOGICALLY CONTAMINTED)

This section provides volume estimates of VOC contaminated soil (relative to SSALs) below the Native 1 soil horizon where radiologically contaminated soil (relative to RSALs) is not present. The total in-place soil volume estimates, therefore, excludes the radiologically contaminated Native 1 soil addressed in Sections 5.2 and 5.3.

Soil exceeding Tier I SSALs occur in two areas within the 903 Pad (Figure 5-3). Proposed Tier I SSAL exceedances in natural soils occur to depths of 16.75 bgs at 92598 and 19 feet bgs at

91198. Therefore, excluding the upper 1.5 feet of radiologically contaminated soil, the artificial fill and the asphalt, a total of 4,063 yd^3 of soil is estimated to exceed Tier I SSALs.

The depth of contamination between proposed Tier I and Tier II SSALs varies from 0 to 6 feet bgs at boring 33291 to 1 foot bgs to the water table (19.0 feet bgs) near boring 97698. . Excluding the upper 1.5 feet of radiologically contaminated soil, artificial fill and asphalt, a total of 6,670 yd^3 of soil is estimated to exceed Tier II SSALs.

5.7 SUMMARY OF MEDIA VOLUME ESTIMATES

This section summarizes volume estimates of soils exceeding Tier I and Tier II RSALs and SSALs, and includes 903 Pad asphalt and artificial fill volume estimates. Tables 5-5 and 5-6 present volumes of asphalt, artificial fill and soil exceeding Tier I SALs and Tier II SALs, respectively.

Table 5-5 Volumes of Asphalt, Artificial Fill and Soils Exceeding Tier I RSALs and SSALs

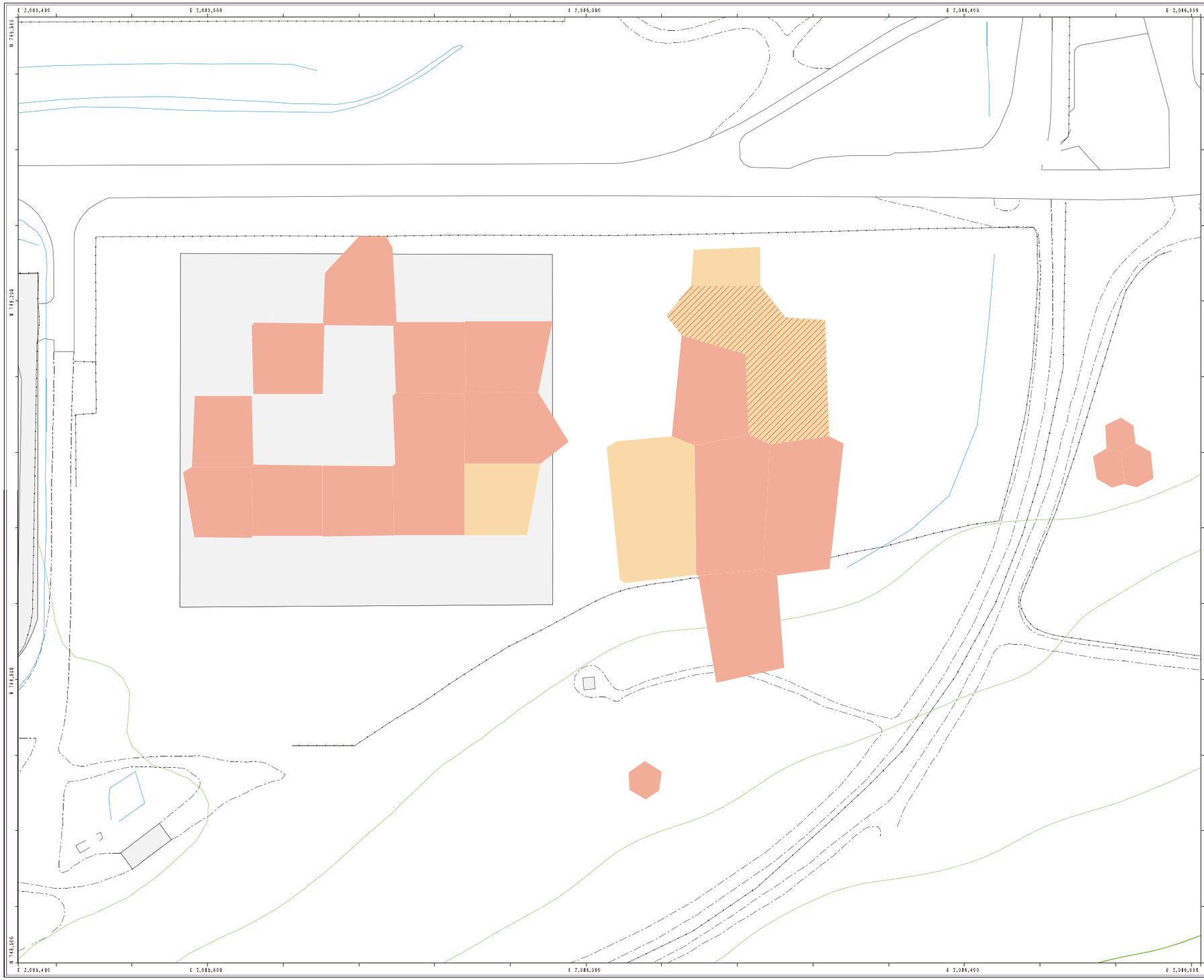
Area/Material	Exceedance	Volume[1] (ft^3)	Volume[1] (yd^3)
903 Pad Soil	RSAL	34,243	1,268
903 Pad Soil	SSAL	109,701	4,063
Lip Area Soil	RSAL	42,670	1,580
Americium Zone Soil	RSAL	2,056	76
Total		**188,670**	**6,987**
903 Pad Asphalt	NA	74,052	2,743
903 Pad Artificial Fill	None	74,052	2,743
Grand Total		**336,774**	**12,473**

[1]Volume represents materials in-place
NA = Not Applicable.

Table 5-6 Volumes of Asphalt, Artificial Fill, and Soils Exceeding Tier II RSALs and SSALs

Area/Material	Exceedance	Volume[1] (ft^3)	Volume[1] (yd^3)
903 Pad Artificial Fill	RSAL	2,813	104
903 Pad Soil	RSAL	66,707	2,471
903 Pad Soil	SSAL	180,090	6,670
Lip Area Soil	RSAL	129,896	4,811
Americium Zone Soil	RSAL	189,667	7,025
Total		**569,173**	**21,081**
903 Pad Asphalt	NA	74,052	2,743
903 Pad Artificial Fill[2]	None	71,239	2,639
Grand Total		**714,464**	**26,463**

[1]Volume represents materials in-place
[2] Excludes 104 yd^3 exceeding RSALs



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Composite Map of Tier I RSAL Exceedances

Figure 5-1

EXPLANATION

- Native 1 (0-6 inches)
- Native 2 (6-12 inches)
- Native 1 and Native 2 (0-12 inches)

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
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N

Scale = 1 : 1290
1 inch represents approximately 108 feet

25 0 50 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by: DynCorp THE ART OF TECHNOLOGY

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MAP ID: 2k-0182

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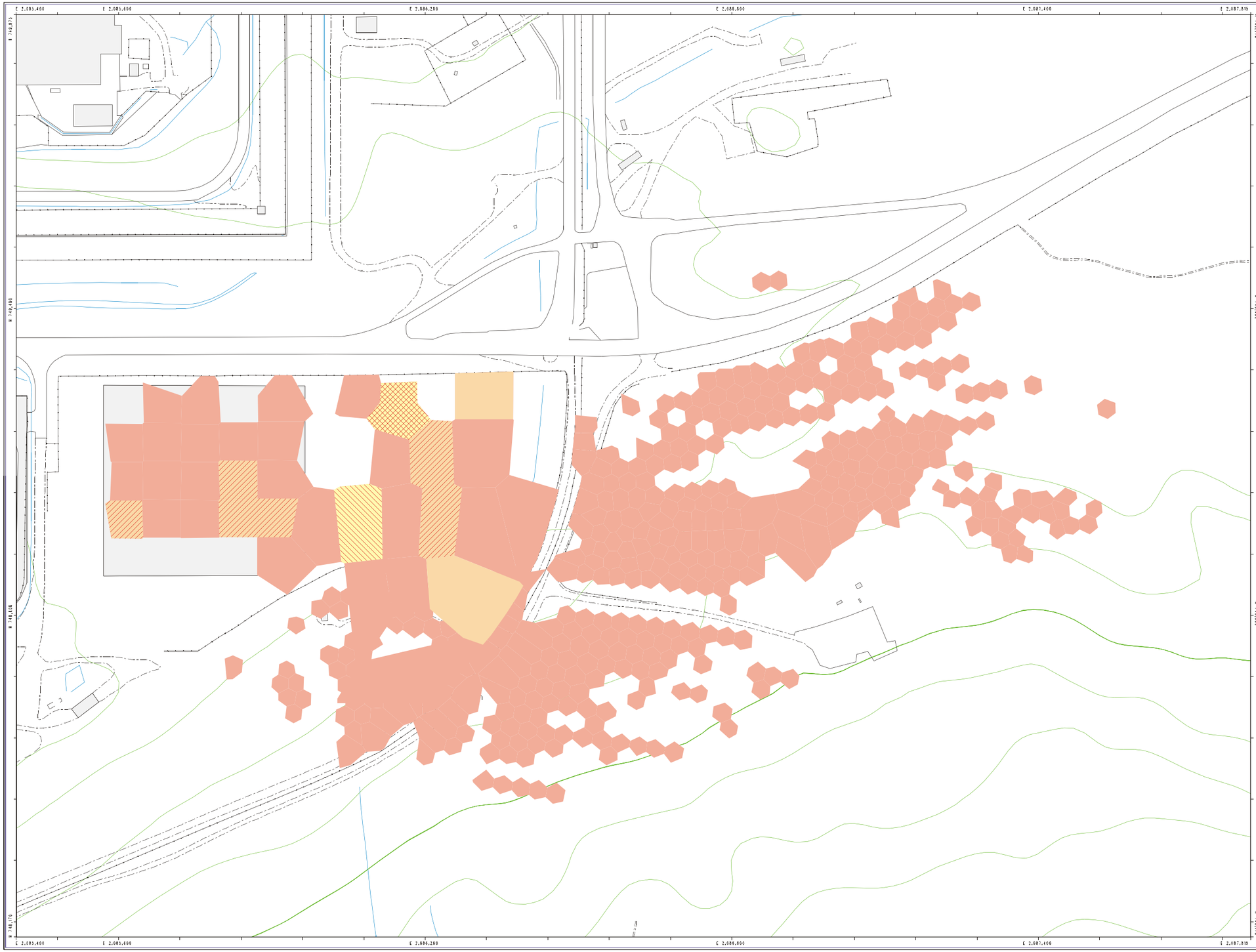

Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Composite Map of Tier II RSAL Exceedances

Figure 5-2

EXPLANATION

- Native 1 (0-6 inches)
- Native 2 (6-12 inches)
- Native 3 (12-18 inches)
- Native 1 and Native 2 (0-12 inches)
- Native 2 and Native 3 (6-18 inches)
- Native 1, Native 2 and Native 2 (0-18 inches)

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DISCLAIMER:
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Scale = 1 : 2330
1 inch represents approximately 194 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

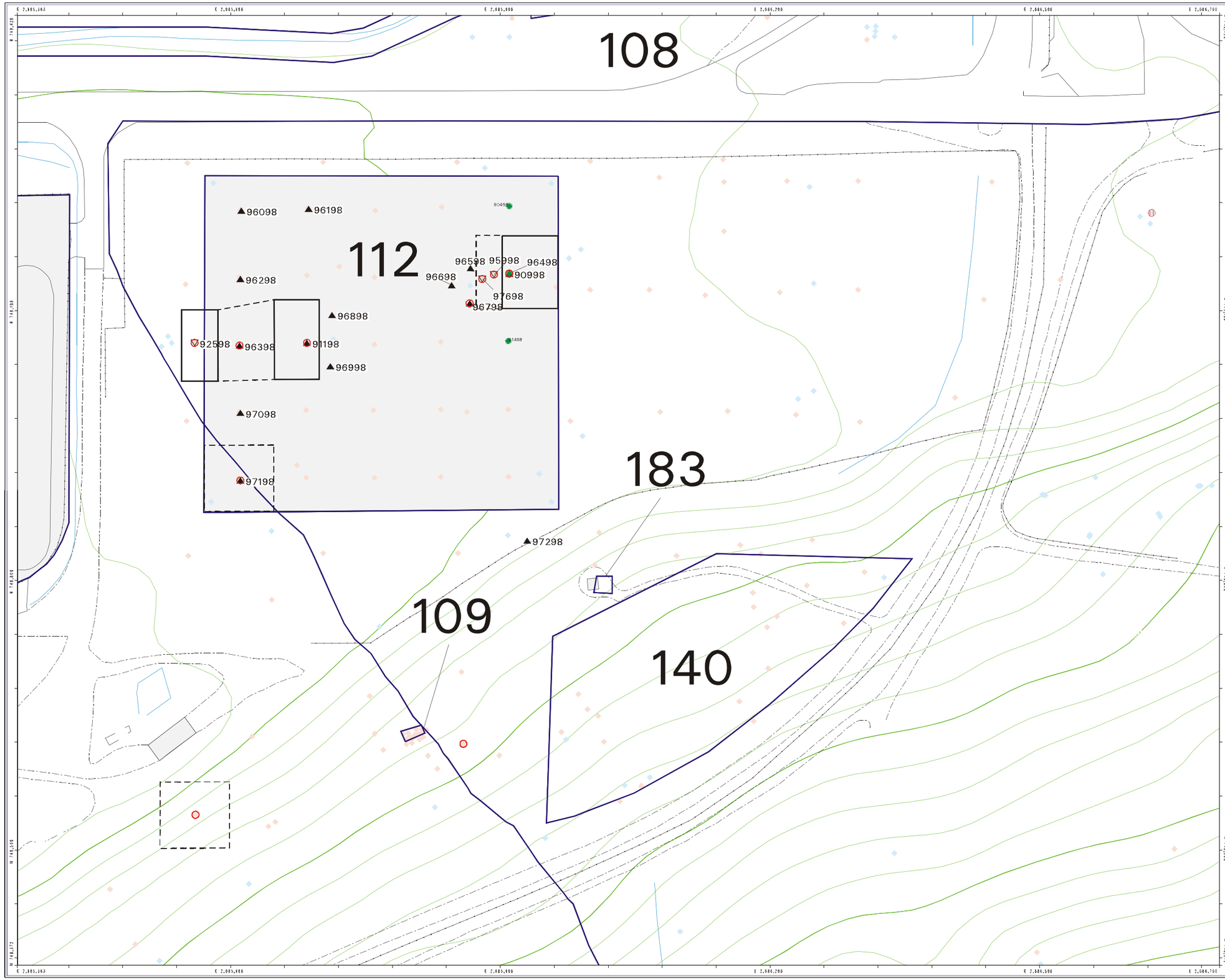
Prepared for:

MAP ID: 2k-0182

July 20, 2000

Original map contents are preserved. Logo and date have changed.

NT_Svr w:/projects/fy2k/2k-0182/rfoa_tier2.aml



Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Extent of Tier I and Tier II Subsurface SAL Contamination
Figure 5-3

EXPLANATION

All Wells and Borings

- Monitoring Wells
- Soil Boreholes

Historical Soil Samples

- Monitoring Wells
- Soil Boreholes

903 Pad VOC Boreholes

- VOC Boreholes, Original
- VOC Boreholes, Stepout
- Radiological Borehole

903 Pad SSAL Areal Exceedences

- Areal Extent of Proposed Tier I SSAL Exceedences
- Areal Extent of Proposed Tier II SSAL Exceedences

NOTE:
Proposed Tier I Exceedeance in red
Proposed Tier II Exceedeance in black
Analyte Values Reported in ug/kg
Depth Intervals Reported in Feet

Individual Hazardous Substance Sites

- Former OU2, Buffer Zone and Industrial Area IHSS

Standard Map Features

- Buildings and other structures
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

Scale = 1 : 1260
1 inch represents 105 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for:

MAP ID: 2k-0166

July 20, 2000

Original map contents are preserved. Logo and date have changed.

NT_Svr w:/projects/fy2k/2k-0166/fig3-4/fig5-3.aml

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Appendix A

Proposes Subsurface SAL Screening Results

Table A1
Proposed Subsurface SAL Screening Results

LOCATION	SAMPLE NO.	PROJECT	CAS No.	COMPOUND	RESULT (µg/kg)	TIER I SSAL (µg/kg)	TIER II SSAL (mg/kg)	LAB QUALIFIER	DEPTH START1 (ft)	DEPTH END1 (ft)	Comments
9098	98A2015-001.010	903 Pad	75-35-4	CIS-1,2-DICHLOROETHENE	4400	14000	140		3.8	4	Approximate Average Depth of Water = 19 ft bgs
33291	BH00284EBU1	OU2	12672-29-6	AROCLOR-1248	7200	531000	5310		0	6	Assumed Depth Interval of 0 to 6 ft.
0168	GT0012IT	OU2	7440-38-2	ARSENIC	5	299	2.99		0	5	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
0171	BP00031IT	OU2	7440-38-2	ARSENIC	3	299	2.99		0	31	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
0271	BP00032IT	OU2	7440-38-2	ARSENIC	5	299	2.99		0	32	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
0368	GT0014IT	OU2	7440-38-2	ARSENIC	4	299	2.99	B	0	5	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
0468	GT0015IT	OU2	7440-38-2	ARSENIC	5	299	2.99		0	5	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
10391	BH00373WCU2	OU2	7440-38-2	ARSENIC	7	299	2.99	B	2.2	8.1	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
21793	BH20319WC	OU2	7440-38-2	ARSENIC	4	299	2.99		20.7	26.7	Mound Area. Background above Tier II level, value < BSL (13.2 mg/Kg)
21793	BH20319WC	OU2	7440-38-2	ARSENIC	10	299	2.99		20.7	26.7	Mound Area. Background above Tier II level, value < BSL (13.2 mg/Kg)
21793	BH20320WC	OU2	7440-38-2	ARSENIC	5	299	2.99		26.7	31.9	Mound Area. Background above Tier II level, value < BSL (13.2 mg/Kg)
21793	BH20321WC	OU2	7440-38-2	ARSENIC	4	299	2.99		31.9	37.4	Mound Area. Background above Tier II level, value < BSL (13.2 mg/Kg)
21893	BH20260WC	OU2	7440-38-2	ARSENIC	6	299	2.99		20.2	26	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
21893	BH20263WC	OU2	7440-38-2	ARSENIC	6	299	2.99		38	44.6	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
21893	BH20277WC	OU2	7440-38-2	ARSENIC	4	299	2.99		44.6	50	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
32691	BH00249EBU1	OU2	7440-38-2	ARSENIC	9	299	2.99		0	6	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
32691	BH00251EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		6	8	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
32891	BH00257EBU1	OU2	7440-38-2	ARSENIC	3	299	2.99		0	6	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
32991	BH00266EBU1	OU2	7440-38-2	ARSENIC	3	299	2.99		6	8	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33291	BH00284EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		0	6	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33591	BH00294EBU1	OU2	7440-38-2	ARSENIC	5	299	2.99		0	6	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33591	BH00299EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		12	16	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33591	BH00297EBU1	OU2	7440-38-2	ARSENIC	5	299	2.99		6	12	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33591	BH00297EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		6	12	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33791	BH00359EBU1	OU2	7440-38-2	ARSENIC	3	299	2.99		12	18	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33791	BH00360EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		18	20	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
33791	BH00355EBU1	OU2	7440-38-2	ARSENIC	4	299	2.99		6	12	Background > Tier II Level. Value < BSL (13.2 mg/Kg)
46692	BH30321IT	OU2	7440-38-2	ARSENIC	9	299	2.99	B			NE Trenches Area. Background > Tier II level. Value > BSL (13.2 mg/Kg)
46692	BH30379IT	OU2	7440-38-2	ARSENIC	5	299	2.99		0	15	NE Trenches Area. Background > Tier II level. Value > BSL (13.2 mg/Kg)
46692	BH30323IT	OU2	7440-38-2	ARSENIC	6	299	2.99		59	90	NE Trenches Area. Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30328IT	OU2	7440-38-2	ARSENIC	4	299	2.99	B			NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30327IT	OU2	7440-38-2	ARSENIC	5	299	2.99	B			NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30328IT	OU2	7440-38-2	ARSENIC	5	299	2.99	B			NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30301IT	OU2	7440-38-2	ARSENIC	4	299	2.99		0	5	NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30303IT	OU2	7440-38-2	ARSENIC	15	299	2.99		10	15	NE Trenches Area. Value < BSL (13.2 mg/Kg)
46792	BH30304IT	OU2	7440-38-2	ARSENIC	3	299	2.99		16	18.5	NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46792	BH30302IT	OU2	7440-38-2	ARSENIC	5	299	2.99		5	10	NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
46892	BH30380IT	OU2	7440-38-2	ARSENIC	4	299	2.99		0	10	NE Trenches Area. Background > Tier II level. Value > BSL (13.2 mg/Kg)
46892	BH30380IT	OU2	7440-38-2	ARSENIC	4	299	2.99		0	10	NE Trenches Area Background > Tier II level. Value > BSL (13.2 mg/Kg)
SS200193	SS20001WC	OU2	7440-38-2	ARSENIC	5	299	2.99	N	0	2	Background > Tier II level. Value < BSL (10.09 mg/Kg)
32691	BH00251EBU1	OU2	7440-41-7	BERYLLIUM	2	104	1.04		6	8	Not Identified as PCOC in OU2 RI Report (DOE, 1995). Value< Background
32891	BH00257EBU1	OU2	7440-41-7	BERYLLIUM	2	104	1.04		0	6	Not Identified as PCOC in OU2 RI Report (DOE, 1995). Value< Background
32891	BH00259EBU1	OU2	7440-41-7	BERYLLIUM	2	104	1.04		6	8	Not Identified as PCOC in OU2 RI Report (DOE, 1995). Value< Background
32991	BH00264EBU1	OU2	7440-41-7	BERYLLIUM	2	104	1.04		0	6	Not Identified as PCOC in OU2 RI Report (DOE, 1995). Value< Background
33291	BH00288EBU1	OU2	7440-41-7	BERYLLIUM	2	104	1.04		12	14	Not Identified as PCOC in OU2 RI Report (DOE, 1995). Value< Background
91198	98A1091-001.033	903 Pad	74-83-9	Bromomethane	690	5980	59.8	JB	3.1	3.4	Approximate Average Depth of Water = 19 ft bgs
21493	BH20147WC	OU2	56-23-5	CARBON TETRACHLORIDE	230	3560	35.6		0	43	Drum Sample for IDM Characterization. Drum # 3528WC
22493	BH20105WC	OU2	56-23-5	CARBON TETRACHLORIDE	200	3560	35.6	D	15.5	15.8	Remediated. NE Trenches Area
22493	BH20105WC	OU2	56-23-5	CARBON TETRACHLORIDE	650	3560	35.6	E	15.5	15.8	Remediated. NE Trenches Area
90998	98A2015-001.010	903 Pad	75-09-2	METHYLENE CHLORIDE	830	578	5.78	B	3.8	4	Probable Contaminant In 903 Pad Area
91198	98A1091-001.033	903 Pad	75-09-2	METHYLENE CHLORIDE	470	578	5.78	JB	3.1	3.4	Probable Contaminant In 903 Pad Area
91198	98A1091-001.034	903 Pad	75-09-2	METHYLENE CHLORIDE	910	578	5.78	B	7.7	8	Probable Contaminant In 903 Pad Area
91198	98A1091-001.035	903 Pad	75-09-2	METHYLENE CHLORIDE	960	578	5.78	B	11.6	11.9	Probable Contaminant In 903 Pad Area
91198	98A1091-001.036	903 Pad	75-09-2	METHYLENE CHLORIDE	980	578	5.78	B	15.5	15.8	Probable Contaminant In 903 Pad Area
91198	98A1091-001.037	903 Pad	75-09-2	METHYLENE CHLORIDE	1500	578	5.78	B	19.1	19.5	Probable Contaminant In 903 Pad Area
91198	98A1091-001.038	903 Pad	75-09-2	METHYLENE CHLORIDE	1200	578	5.78	B	19.5	19.8	Probable Contaminant In 903 Pad Area

Table A1
Proposed Subsurface SAL Screening Results

92598	98A1092-001.033	903 Pad	75-09-2	METHYLENE CHLORIDE	1400	578	5.78	B	3.5	4	Probable Contaminant In 903 Pad Area
92598	98A1092-001.034	903 Pad	75-09-2	METHYLENE CHLORIDE	1500	578	5.78	B	7.5	8	Probable Contaminant In 903 Pad Area
92598	98A1092-001.035	903 Pad	75-09-2	METHYLENE CHLORIDE	1700	578	5.78	B	12	12.5	Probable Contaminant In 903 Pad Area
92598	98A1092-001.036	903 Pad	75-09-2	METHYLENE CHLORIDE	1700	578	5.78	B	16	16.75	Probable Contaminant In 903 Pad Area
96398	99A4102-001.003	903 Pad	75-09-2	METHYLENE CHLORIDE	380	578	5.78	J	4.3	4.8	Probable Contaminant In 903 Pad Area
96398	99A4102-001.006	903 Pad	75-09-2	METHYLENE CHLORIDE	350	578	5.78	J	8.4	8.9	Probable Contaminant In 903 Pad Area
96398	99A4102-001.009	903 Pad	75-09-2	METHYLENE CHLORIDE	410	578	5.78	J	12.4	12.7	Probable Contaminant In 903 Pad Area
96398	99A4102-001.012	903 Pad	75-09-2	METHYLENE CHLORIDE	390	578	5.78	J	16.2	16.4	Probable Contaminant In 903 Pad Area
97198	99A4102-002.006	903 Pad	75-09-2	METHYLENE CHLORIDE	200	578	5.78	J	4.4	4.8	Probable Contaminant In 903 Pad Area
97198	99A4102-002.003	903 Pad	75-09-2	METHYLENE CHLORIDE	380	578	5.78	J	7.3	7.6	Probable Contaminant In 903 Pad Area
97198	99A4102-002.018	903 Pad	75-09-2	METHYLENE CHLORIDE	460	578	5.78	BJ	24.4	24.8	Probable Contaminant In 903 Pad Area
97698	99A8275-003.002	903 Pad	75-09-2	METHYLENE CHLORIDE	28.6	578	5.78	B	11.2	11.6	Probable Contaminant In 903 Pad Area
97698	99A8275-004.002	903 Pad	75-09-2	METHYLENE CHLORIDE	35.4	578	5.78	B	13.5	13.9	Probable Contaminant In 903 Pad Area
97698	99A8275-005.002	903 Pad	75-09-2	METHYLENE CHLORIDE	29.9	578	5.78	B	16.3	16.7	Probable Contaminant In 903 Pad Area
97698	99A8275-008.002	903 Pad	75-09-2	METHYLENE CHLORIDE	21.6	578	5.78	B	18.2	18.8	Probable Contaminant In 903 Pad Area
00891	BH00032WCU2	OU2	75-09-2	METHYLENE CHLORIDE	10	578	5.78	B	16.9	18.9	Probable contaminant in 903 Pad Area.
03391	BH00107WCU2	OU2	75-09-2	METHYLENE CHLORIDE	11	578	5.78	B	13	13.2	Probable contaminant in 903 Pad Area.
03391	BH00109WCU2	OU2	75-09-2	METHYLENE CHLORIDE	7	578	5.78	B	22.6	22.8	Probable contaminant in 903 Pad Area. Below Water Table.
12991	BH00568WCU2	OU2	75-09-2	METHYLENE CHLORIDE	6	578	5.78		26.7	26.9	Probable contaminant in 903 Pad Area. Below Water Table.
21293	BH20292WC	OU2	75-09-2	METHYLENE CHLORIDE	34	578	5.78	BD	26	149	Drum Sample for IDM Characterization.
21393	BH20110WC	OU2	75-09-2	METHYLENE CHLORIDE	72	578	5.78		45	209	Drum Sample for IDM Characterization.
21393	BH20102WC	OU2	75-09-2	METHYLENE CHLORIDE	53	578	5.78		45	209	Drum Sample for IDM Characterization.
21593	BH20089WC	OU2	75-09-2	METHYLENE CHLORIDE	16	578	5.78		0	24.3	Mound Area. Drum Sample for IDM Characterization
21693	BH20098WC	OU2	75-09-2	METHYLENE CHLORIDE	16	578	5.78	BJ	0	47	NE Trenches Area Remediated
21693	BH20070WC	OU2	75-09-2	METHYLENE CHLORIDE	6	578	5.78		0	25	NE Trenches Area Remediated
21693	BH20069WC	OU2	75-09-2	METHYLENE CHLORIDE	7	578	5.78		22.7	23	NE Trenches Area Remediated
21693	BH20071WC	OU2	75-09-2	METHYLENE CHLORIDE	11	578	5.78		24.7	25	NE Trenches Area Remediated
21693	BH20072WC	OU2	75-09-2	METHYLENE CHLORIDE	6	578	5.78		26.7	27	NE Trenches Area Remediated
21693	BH20073WC	OU2	75-09-2	METHYLENE CHLORIDE	7	578	5.78		28.7	29	NE Trenches Area Remediated
21693	BH20074WC	OU2	75-09-2	METHYLENE CHLORIDE	9	578	5.78		30.7	31	NE Trenches Area Remediated
21693	BH20088WC	OU2	75-09-2	METHYLENE CHLORIDE	7	578	5.78		32.7	33	NE Trenches Area Remediated
22293	BH20343WC	OU2	75-09-2	METHYLENE CHLORIDE	48	578	5.78	BJ	51	85	Mound Area. Drum Sample for IDM Characterization
22493	BH20105WC	OU2	75-09-2	METHYLENE CHLORIDE	40	578	5.78	BD	15.5	15.8	NE Trenches Area Remediated
24093	BH20611WC	OU2	75-09-2	METHYLENE CHLORIDE	12	578	5.78		1.6	1.8	Remediated. NE Trenches Area
24093	BH20614WC	OU2	75-09-2	METHYLENE CHLORIDE	13	578	5.78		15.1	15.3	Remediated. NE Trenches Area
24193	BH20626WC	OU2	75-09-2	METHYLENE CHLORIDE	10	578	5.78	J	35.6	35.9	Remediated. NE Trenches Area
24593	BH20608WC	OU2	75-09-2	METHYLENE CHLORIDE	20	578	5.78		7.5	7.8	Remediated. NE Trenches Area
25694	BH20656WC	OU2	75-09-2	METHYLENE CHLORIDE	500	578	5.78	BJ	11.8	12	NE Trenches Area Remediated
90998	98A2015-001.010	4	127-18-4	TETRACHLOROETHENE	6100	3150	31.5		3.8	4	Approximate Average Depth of Water = 19 ft bgs
95998	99A7799-001.002	5.6	127-18-4	TETRACHLOROETHENE	1540	3150	31.5	E	5	5.6	Approximate Average Depth of Water = 19 ft bgs
95998	99A7799-006.002	25	127-18-4	TETRACHLOROETHENE	343	3150	31.5	E	24.6	25	Approximate Average Depth of Water = 19 ft bgs
96498	99A3210-001.013	5.2	127-18-4	TETRACHLOROETHENE	800	3150	31.5	J	4.8	5.2	Approximate Average Depth of Water = 19 ft bgs
96798	99A6650-005.002	20.8	127-18-4	TETRACHLOROETHENE	72.2	3150	31.5		20.4	20.8	Approximate Average Depth of Water = 19 ft bgs
97698	99A8275-004.002	13.9	127-18-4	TETRACHLOROETHENE	40.5	3150	31.5		13.5	13.9	Approximate Average Depth of Water = 19 ft bgs
97698	99A8275-009.002	19.8	127-18-4	TETRACHLOROETHENE	76.3	3150	31.5		19.4	19.8	Approximate Average Depth of Water = 19 ft bgs
21693	BH20085WC	OU2	127-18-4	TETRACHLOROETHENE	59	3150	31.5		0	47	Remediated. NE Trenches Area
21793	BH20285WC	OU2	127-18-4	TETRACHLOROETHENE	130	3150	31.5		23.1	23.4	Mound Area
21793	BH20315WC	OU2	127-18-4	TETRACHLOROETHENE	170	3150	31.5		27.5	27.8	Mound Area
21793	BH20316WC	OU2	127-18-4	TETRACHLOROETHENE	100	3150	31.5		31.6	31.9	Mound Area
21793	BH20317WC	OU2	127-18-4	TETRACHLOROETHENE	32	3150	31.5		35.1	35.4	Mound Area
22493	BH20137WC	OU2	127-18-4	TETRACHLOROETHENE	42	3150	31.5		0	52	Remediated. NE Trenches Area
22493	BH20157WC	OU2	127-18-4	TETRACHLOROETHENE	57	3150	31.5		0	52	Remediated. NE Trenches Area
22493	BH20136WC	OU2	127-18-4	TETRACHLOROETHENE	93	3150	31.5		0	52	Remediated. NE Trenches Area
24793	BH20600WC	OU2	127-18-4	TETRACHLOROETHENE	1100000	3150	31.5		7.7	8	Remediated. NE Trenches Area
24793	BH20601WC	OU2	127-18-4	TETRACHLOROETHENE	260000	3150	31.5		7.7	8	Remediated. NE Trenches Area
25294	BH20654WC	OU2	127-18-4	TETRACHLOROETHENE	190	3150	31.5		6.75	7	Remediated. NE Trenches Area
25594	BH20658WC	OU2	127-18-4	TETRACHLOROETHENE	730000	3150	31.5		15.8	16	NE Trenches Area Remediated
25594	BH20660WC	OU2	127-18-4	TETRACHLOROETHENE	510000	3150	31.5		9.8	10	NE Trenches Area Remediated

Table A1
Proposed Subsurface SAL Screening Results

25694	BH20656WC	OU2	127-18-4	TETRACHLOROETHENE	27000	3150	31.5		11.8	12	NE Trenches Area Remediated
25694	BH20656WC	OU2	127-18-4	TETRACHLOROETHENE	38000	3150	31.5	E	11.8	12	NE Trenches Area Remediated
24793	BH20600WC	OU2	108-88-3	TOLUENE	7600	707000	7070	J	7.7	8	Remediated. NE Trenches Area
90998	98A2015-001.010	903 Pad	79-01-6	TRICHLOROETHENE	290	3280	32.8	J	3.8	4	Approximate Average Depth of Water = 19 ft bgs
21493	BH20147WC	OU2	79-01-6	TRICHLOROETHENE	130	3280	32.8		0	43	Drum Sample for IDM Characterization. Drum # 3528WC
21893	BH20244WC	OU2	79-01-6	TRICHLOROETHENE	39	3280	32.8		0	18.6	Drum Sample for IDM Characterization. Drum #'s 2824WC, 2825WC
21893	BH20225WC	OU2	79-01-6	TRICHLOROETHENE	56	3280	32.8		0	26	Drum Sample for IDM Characterization. Drum #'s 3651WC-3654WC
21893	BH20256WC	OU2	79-01-6	TRICHLOROETHENE	5700	3280	32.8		23.1	23.4	Probable Contaminant
24793	BH20600WC	OU2	79-01-6	TRICHLOROETHENE	8100	3280	32.8	J	7.7	8	Remediated. NE Trenches Area
25694	BH20656WC	OU2	79-01-6	TRICHLOROETHENE	280	3280	32.8	J	11.8	12	NE Trenches Area Remediated

BSL = Background Screening Level
SSAL=Subsurface Soil Action Level
Arsenic and Beryllium reported in mg/kg

Appendice B is Unavailable

There are five Rocky Flats Reading Rooms in the Denver metro area. Their addresses are below.

These rooms contain a huge selection of documents produced by Rocky Flats over the years, from environmental studies and reports to statistics on budgets and employment. The main reading room is located at Front Range Community College and is the most current and comprehensive. For more information, call the Front Range Community College Reading Room at (303) 469-4435.

The five Rocky Flats Reading Rooms locations are as follows:

Front Range Community College
3705 W. 112th Ave.
Westminster, CO 80030
(303) 469-4435

Rocky Flats Citizens Advisory Board
9035 N. Wadsworth Parkway, Suite 2250
Westminster, CO 80021
(303) 420-7855

Colorado Department of Public Health & Environment
Information Center
4300 Cherry Creek Dr. South, Bldg. A
Denver, CO 80222-1530
(303) 692-2037

U.S. Environmental Protection Agency
Region VIII Superfund Records Center
999 18th Street, Suite 500
Denver, CO 80202-2466
(303) 312-6473

Standley Lake Library
8485 Kipling Street
Arvada, CO 80005
(303) 456-0806

Appendix C

Precision (DER and RPD) Calculations

Surface Soil Charcterization Precision Resuts
HPGe Survey - Americium-241

Measurment Set	Measurement Location	Northing	Easting	Result Identifer	Isotope	Result	Unit	Qualifer	Counting Error	MDA	TPE	DER
1	4	749504.2	2086712.6	REAL	Am-241	3.627	pCi/g		1.4611	1.167	2.549	
				RP	Am-241	2.91	pCi/g		1.3394	1.047	2.212	0.2124
2	34	749488.6	2086940.3	REAL	Am-241	8.113	pCi/g		2.5898	1.325	5.024	
				RP	Am-241	8.698	pCi/g		2.7235	1.312	5.333	0.0798
3	50	749457.1	2086923.4	REAL	Am-241	10.42	pCi/g		3.1812	1.545	6.306	
				RP	Am-241	11.62	pCi/g		3.43	1.411	6.916	0.1286
4	70	749274.8	2086547.4	REAL	Am-241	0.879	pCi/g	U	0	0.879	0	
				RP	Am-241	0.858	pCi/g	U	0	0.858	0	
5	102	748741.8	2086501.7	REAL	Am-241	23.62	pCi/g		6.5632	1.67	13.65	
				RP	Am-241	22.87	pCi/g		6.4112	1.884	13.27	0.0397
6	92	748758.4	2086788.2	REAL	Am-241	12.22	pCi/g		9.2351	1.906	12.9	
				RP	Am-241	13.39	pCi/g		4.0278	1.981	8.045	0.0772
7	103	748762.9	2086525.2	REAL	Am-241	27.61	pCi/g		7.9047	2.422	16.19	
				RP	Am-241	25.32	pCi/g		7.2465	2.148	14.84	0.1042
8	144	748686.7	2086456.2	REAL	Am-241	12.48	pCi/g		3.651	1.553	7.394	
				RP	Am-241	12.76	pCi/g		3.762	1.671	7.59	0.0268
9	143	748712.7	2086475.7	REAL	Am-241	27.69	pCi/g		7.5668	2.517	15.87	
				RP	Am-241	25.6	pCi/g		7.0445	2.158	14.72	0.0965
10	188	748543.5	2086617.9	REAL	Am-241	13.03	pCi/g		3.9436	1.84	7.852	
				RP	Am-241	12.76	pCi/g		3.9288	1.936	7.758	0.0240
11	187	748569.8	2086637.6	REAL	Am-241	11.14	pCi/g		3.3664	1.557	6.707	
				RP	Am-241	10.99	pCi/g		3.4046	1.737	6.702	0.0151
12	224	748530.6	2086328	REAL	Am-241	14.34	pCi/g		4.4282	2.254	8.732	
				RP	Am-241	14.75	pCi/g		4.4725	2.119	8.897	0.0326
13	223	748553.6	2086348.4	REAL	Am-241	18.37	pCi/g		5.1655	1.54	10.68	
				RP	Am-241	18.16	pCi/g		13.326	1.686	18.77	0.0098
14	293	749282.1	2087177.7	REAL	Am-241	17.19	pCi/g		4.9867	1.815	10.14	
				RP	Am-241	14.25	pCi/g		4.0446	1.389	8.32	0.2240
15	292	749308.9	2087156.3	REAL	Am-241	9.506	pCi/g		2.9194	1.391	5.771	
				RP	Am-241	9.568	pCi/g		2.8826	1.388	5.753	0.0076

Surface Soil Charcterization Precision Resuts
HPGe Survey - Americium-241

Measurment Set	Measurement Location	Northing	Easting	Result Identifer	Isotope	Result	Unit	Qualifer	Counting Error	MDA	TPE	DER
16	328	749360.4	2087307	REAL	Am-241	9.453	pCi/g		3.0676	1.812	5.904	
				RP	Am-241	8.771	pCi/g		2.8074	1.575	5.439	0.0850
17	327	749384.1	2087288.3	REAL	Am-241	10.36	pCi/g		2.9936	1.12	6.1	
				RP	Am-241	9.635	pCi/g		2.9191	1.407	5.81	0.0856
18	347	749466.9	2087225.4	REAL	Am-241	5.972	pCi/g		2.3238	1.765	4.115	
				RP	Am-241	6.221	pCi/g		2.2445	1.553	4.111	0.0428
19	348	749473.4	2087259.1	REAL	Am-241	8.385	pCi/g		2.4629	1.193	4.978	
				RP	Am-241	9.241	pCi/g		2.6696	1.218	5.442	0.1160
20	392	749237.3	2087288.3	REAL	Am-241	17	pCi/g		4.8726	1.488	9.974	
				RP	Am-241	16.44	pCi/g		4.7944	1.73	9.726	0.0405
21	391	749265.7	2087268.3	REAL	Am-241	6.945	pCi/g		2.3826	1.517	4.466	
				RP	Am-241	6.438	pCi/g		2.2561	1.498	4.188	0.0827
22	424	749122.1	2086857.6	REAL	Am-241	1.148	pCi/g	U	0	1.148	0	
				RP	Am-241	1.178	pCi/g	U	0	1.178	0	
23	423	749152.5	2086871.9	REAL	Am-241	4.422	pCi/g		1.5688	1.092	2.895	
				RP	Am-241	4.226	pCi/g		1.5708	1.165	2.839	0.0483
24	466	749030.8	2086645.6	REAL	Am-241	15.33	pCi/g		4.7461	2.335	9.346	
				RP	Am-241	17.95	pCi/g		5.3281	2.178	10.71	0.1841
25	465	749061.8	2086627.6	REAL	Am-241	13.12	pCi/g		4.0085	1.864	7.943	
				RP	Am-241	14.4	pCi/g		4.3058	1.828	8.626	0.1096
26	491	749106.5	2087170.1	REAL	Am-241	14.02	pCi/g		3.9786	1.636	8.185	
				RP	Am-241	9.585	pCi/g		2.7567	1.292	5.632	0.4466
27	493	749103.8	2087136.5	REAL	Am-241	13.09	pCi/g		3.8208	1.552	7.747	
				RP	Am-241	13.44	pCi/g		3.9737	1.776	8.006	0.0319
28	534	748827.7	2086730.2	REAL	Am-241	8.258	pCi/g		3.0181	2.179	5.495	
				RP	Am-241	7.445	pCi/g		2.6872	1.93	4.921	0.1103
29	533	748861.1	2086716.3	REAL	Am-241	18.09	pCi/g		5.1869	1.625	10.62	
				RP	Am-241	18.44	pCi/g		5.1799	1.377	10.71	0.0233
30	562	748943.3	2086803.6	REAL	Am-241	14.25	pCi/g		4.756	2.974	9.03	
				RP	Am-241	15.91	pCi/g		4.8554	2.403	9.629	0.1261

Surface Soil Charcterization Precision Resuts
HPGe Survey - Americium-241

Measurment Set	Measurement Location	Northing	Easting	Result Identifer	Isotope	Result	Unit	Qualifer	Counting Error	MDA	TPE	DER
31	563	748908.1	2086813.2	REAL	Am-241	18.87	pCi/g		5.436	2.047	11.1	
				RP	Am-241	18.22	pCi/g		5.1838	1.816	10.65	0.0425
32	587	749006.2	2086641.5	REAL	Am-241	34.06	pCi/g		9.2692	1.583	19.49	
				RP	Am-241	32.1	pCi/g		8.8266	2.088	18.46	#REF!
33	624	748997.5	2086833.9	REAL	Am-241	21	pCi/g		5.8026	2.107	12.1	
				RP	Am-241	20.01	pCi/g		5.611	2.467	11.61	0.0590
34	622	748992.1	2086763.2	REAL	Am-241	17.94	pCi/g		5.2004	1.698	10.58	
				RP	Am-241	17.73	pCi/g		5.173	1.834	10.49	0.0147
35	666	748633.6	2085992	REAL	Am-241	2.522	pCi/g		1.6399	1.625	2.397	
				RP	Am-241	2.18	pCi/g		1.3419	1.312	1.996	0.1099
36	665	748662.6	2086013.9	REAL	Am-241	4.508	pCi/g		1.8583	1.51	3.211	
				RP	Am-241	3.562	pCi/g		1.3985	1.079	2.467	0.2336
37	705	748554.4	2085849.5	REAL	Am-241	8.033	pCi/g		2.4323	1.189	4.842	
				RP	Am-241	8.163	pCi/g		2.4687	1.234	4.918	0.0188
38	706	748528.9	2085828	REAL	Am-241	7.134	pCi/g		2.526	1.762	4.666	
				RP	Am-241	7.854	pCi/g		2.5948	1.624	4.951	0.1059
39	770	748550.6	2086926.9	REAL	Am-241	5.353	pCi/g		1.7862	1.131	3.392	
				RP	Am-241	4.531	pCi/g		1.6108	1.127	2.97	0.1824
40	769	748558.5	2086894.8	REAL	Am-241	8.108	pCi/g		2.6069	1.667	5.039	
				RP	Am-241	7.873	pCi/g		2.5173	1.632	4.879	0.0335
41	785	749066.9	2087188.6	REAL	Am-241	8.525	pCi/g		2.5766	1.148	5.134	
				RP	Am-241	7.917	pCi/g		2.4615	1.264	4.837	0.0862
42	786	749053	2087208.3	REAL	Am-241	23.06	pCi/g		6.3291	1.923	13.25	
				RP	Am-241	23.69	pCi/g		6.3199	1.624	13.43	0.0330
43	837	748467.5	2086066.4	REAL	Am-241	5.876	pCi/g		2.1689	1.526	3.932	
				RP	Am-241	4.834	pCi/g		1.6679	1.029	3.118	0.2077
44	836	748458.2	2086097.7	REAL	Am-241	5.479	pCi/g		1.9885	1.401	3.632	
				RP	Am-241	5.652	pCi/g		2.0624	1.469	3.758	0.0332
45	874	748829.3	2087427.7	REAL	Am-241	9.092	pCi/g		2.89	1.63	5.617	
				RP	Am-241	10.74	pCi/g		3.4262	2.017	6.649	0.1896

Surface Soil Charcterization Precision Resuts
HPGe Survey - Americium-241

Measurment Set	Measurement Location	Northing	Easting	Result Identifer	Isotope	Result	Unit	Qualifer	Counting Error	MDA	TPE	DER
46	873	748800.5	2087445.2	REAL	Am-241	6.727	pCi/g		2.2551	1.402	4.273	
				RP	Am-241	6.694	pCi/g		2.1906	1.295	4.199	0.0055
47	902	749150.1	2087462.7	REAL	Am-241	1.256	pCi/g	U	0	1.256	0	
				RP	Am-241	1.255	pCi/g	U	0	1.255	0	
48	903	749159.1	2087493.4	REAL	Am-241	0.393	pCi/g	J	0.69657	0.755	0.814	
				RP	Am-241	0.676	pCi/g	J	0.70307	0.737	0.906	0.2325
49	946	748935.6	2087258.4	REAL	Am-241	4.619	pCi/g		1.7668	1.296	3.152	
				RP	Am-241	3.791	pCi/g		1.8493	1.635	2.987	0.1906
50	965	748838.4	2086052.2	REAL	Am-241	24.75	pCi/g		6.8179	1.578	14.24	
				RP	Am-241	25.01	pCi/g		6.8798	1.674	14.38	0.0130
51	986	748836.5	2086172.8	REAL	Am-241	20.35	pCi/g		5.627	1.622	11.73	
				RP	Am-241	20.87	pCi/g		5.7331	1.601	11.99	0.0308
52	1003	748566.4	2085682.7	REAL	Am-241	1.14	pCi/g		0.9978	1.031	1.34	
				RP	Am-241	0.93	pCi/g	J	1.065	1.13	1.344	0.1104
53	1002	748594.5	2085666.3	REAL	Am-241	1.095	pCi/g	U	0	1.095	0	
				RP	Am-241	1.132	pCi/g	U	0	1.132	0	
54	1036	748851.9	2087437.9	REAL	Am-241	7.261	pCi/g		2.4047	1.471	4.583	
				RP	Am-241	7.442	pCi/g		2.3804	1.339	4.613	0.0278
55	1055	749317.3	2087419.5	REAL	Am-241	7.141	pCi/g		2.3449	1.483	4.487	
				RP	Am-241	7.622	pCi/g		2.3994	1.446	4.686	0.0742
56	1069	749181.2	2087619.6	REAL	Am-241	0.918	pCi/g	U	0	0.918	0	
				RP	Am-241	0.912	pCi/g	U	0	0.912	0	
57	1107	749240.8	2086516.1	REAL	Am-241	0.992	pCi/g	U	0	0.992	0	
				RP	Am-241	1.042	pCi/g	U	0	1.042	0	
58	1106	749271.9	2086516.4	REAL	Am-241	0.829	pCi/g	U	0	0.829	0	
				RP	Am-241	0.528	pCi/g	J	1.1216	1.222	1.28	0.2354

Surface Soil Characterization Program
Precision Results
Alpha Spectroscopy

HPGe MEAS. LOCATION	SAMPLE TYPE	LOC	SAMPLE NUMBER	ANALYTE	RESULT	UNIT_ CODE	Q	DET. LIMIT	RC_SIGMA _ERROR
30	Duplicate	1 meter	99A5936-005.001	Am-241	4.4612	PCI/G		0.0675	0.3741
30	Real	1 meter	99A5936-004.001	Am-241	4.6643	PCI/G		0.0618	0.3659
30	Duplicate	3 meter	99A5936-007.001	Am-241	3.1966	PCI/G		0.0216	0.3134
30	Real	3 meter	99A5936-006.001	Am-241	3.574	PCI/G		0.1296	0.4259
30	Duplicate	Center	99A5936-003.001	Am-241	1.7105	PCI/G		0.0948	0.2759
30	Real	Center	99A5936-002.001	Am-241	2.3659	PCI/G		0.1332	0.332
460	Duplicate	1 meter	99A3372-002.008	Am-241	172.9098	PCI/G		.6272	5.4249
460	Real	1 meter	99A3372-002.004	Am-241	151.9866	PCI/G		.8476	5.5795
460	Duplicate	3 meter	99A3372-002.009	Am-241	145.2979	PCI/G		.7359	4.8513
460	Real	3 meter	99A3372-002.006	Am-241	137.9899	PCI/G		1.1001	5.5697
460	Duplicate	Center	99A3372-002.007	Am-241	175.1638	PCI/G		.7965	5.6641
460	Real	Center	99A3372-002.002	Am-241	90.1227	PCI/G		.6611	4.0973
669	Duplicate	1 meter	99A4878-006.001	Am-241	66.7147	PCI/G		0.1048	3.1482
669	Real	1 meter	99A4878-005.001	Am-241	55.0517	PCI/G		0.193	2.8592
669	Duplicate	3 meter	99A4878-008.001	Am-241	51.0332	PCI/G		0.1612	2.5161
669	Real	3 meter	99A4878-007.001	Am-241	60.4235	PCI/G		0.1123	3.1018
669	Duplicate	Center	99A4878-004.001	Am-241	75.9211	PCI/G		0.1046	3.3548
669	Real	Center	99A4878-003.001	Am-241	40.8194	PCI/G		0.1006	2.413
30	Duplicate	1 meter	99A5936-005.001	Pu-239/240	23.1372	PCI/G		0.0209	0.8293
30	Real	1 meter	99A5936-004.001	Pu-239/240	21.7524	PCI/G		0.0217	0.8192
30	Duplicate	3 meter	99A5936-007.001	Pu-239/240	15.5486	PCI/G		0.0659	1.2054
30	Real	3 meter	99A5936-006.001	Pu-239/240	23.8498	PCI/G		0.0769	1.0835
30	Duplicate	Center	99A5936-003.001	Pu-239/240	8.4155	PCI/G		0.1131	0.7811
30	Real	Center	99A5936-002.001	Pu-239/240	12.8235	PCI/G		0.0653	0.6603
460	Duplicate	1 meter	99A3372-002.008	Pu-239/240	684.6637	PCI/G		.2833	12.2161
460	Real	1 meter	99A3372-002.004	Pu-239/240	1481.6998	PCI/G		.1612	18.4008
460	Duplicate	3 meter	99A3372-002.009	Pu-239/240	841.5062	PCI/G		.4739	15.1618
460	Real	3 meter	99A3372-002.006	Pu-239/240	675.0613	PCI/G		.3265	10.7885
460	Duplicate	Center	99A3372-002.007	Pu-239/240	782.3574	PCI/G		.2869	13.1426
460	Real	Center	99A3372-002.002	Pu-239/240	554.3172	PCI/G		.3912	11.1808
669	Duplicate	1 meter	99A4878-006.001	Pu-239/240	435.6164	PCI/G		0.2219	8.6241
669	Real	1 meter	99A4878-005.001	Pu-239/240	318.3239	PCI/G		0.1196	7.3486
669	Duplicate	3 meter	99A4878-008.001	Pu-239/240	297.2583	PCI/G		0.3393	7.2987
669	Real	3 meter	99A4878-007.001	Pu-239/240	376.36	PCI/G		0.2867	8.3559
669	Duplicate	Center	99A4878-004.001	Pu-239/240	525.3358	PCI/G		0.2608	9.415
669	Real	Center	99A4878-003.001	Pu-239/240	265.908	PCI/G		0.1194	6.7098
30	Duplicate	1 meter	99A5936-005.001	U-233,-234	0.7917	PCI/G	J	0.1082	0.1928
30	Real	1 meter	99A5936-004.001	U-233,-234	0.7905	PCI/G	J	0.0798	0.184
30	Duplicate	3 meter	99A5936-007.001	U-233,-234	0.6254	PCI/G	J	0.0767	0.1677
30	Real	3 meter	99A5936-006.001	U-233,-234	0.5568	PCI/G	J	0.1464	0.1997
30	Duplicate	Center	99A5936-003.001	U-233,-234	2.3662	PCI/G		0.3407	0.6882
30	Real	Center	99A5936-002.001	U-233,-234	0.8336	PCI/G	J	0.101	0.2129
460	Duplicate	1 meter	99A3372-002.008	U-233,-234	1.0197	PCI/G		.0331	.1613
460	Real	1 meter	99A3372-002.004	U-233,-234	.8624	PCI/G	J	.0432	.1556
460	Duplicate	3 meter	99A3372-002.009	U-233,-234	1.184	PCI/G		.0794	.2339
460	Real	3 meter	99A3372-002.006	U-233,-234	1.1367	PCI/G		.0403	.1879
460	Duplicate	Center	99A3372-002.007	U-233,-234	.8937	PCI/G	J	.052	.1574
460	Real	Center	99A3372-002.002	U-233,-234	1.1157	PCI/G		.0458	.1721

Surface Soil Characterization Program
Precision Results
Alpha Spectroscopy

HPGe MEAS. LOCATION	SAMPLE TYPE	LOC	SAMPLE NUMBER	ANALYTE	RESULT	UNIT_ CODE	Q	DET. LIMIT	RC_SIGMA _ERROR
669	Duplicate	1 meter	99A4878-006.001	U-233,-234	0.842	PCI/G	J	0.2601	0.3213
669	Real	1 meter	99A4878-005.001	U-233,-234	0.6224	PCI/G	J	0.1497	0.2696
669	Duplicate	3 meter	99A4878-008.001	U-233,-234	0.8276	PCI/G	J	0.2608	0.3128
669	Real	3 meter	99A4878-007.001	U-233,-234	0.9393	PCI/G	J	0.2068	0.326
669	Duplicate	Center	99A4878-004.001	U-233,-234	0.6928	PCI/G	J	0.4855	0.4082
669	Real	Center	99A4878-003.001	U-233,-234	0.7556	PCI/G	J	0.3322	0.3191
30	Duplicate	1 meter	99A5936-005.001	U-235	0.08	PCI/G	J	0.0589	0.0614
30	Real	1 meter	99A5936-004.001	U-235	0.0413	PCI/G	U	0.0547	0.0433
30	Duplicate	3 meter	99A5936-007.001	U-235	0.0434	PCI/G	U	0.0575	0.0454
30	Real	3 meter	99A5936-006.001	U-235	0.1111	PCI/G	U	0.1175	0.0926
30	Duplicate	Center	99A5936-003.001	U-235	0.1025	PCI/G	U	0.1385	0.1417
30	Real	Center	99A5936-002.001	U-235	0.0907	PCI/G	J	0.0824	0.0725
460	Duplicate	1 meter	99A3372-002.008	U-235	.0883	PCI/G	J	.0441	.0489
460	Real	1 meter	99A3372-002.004	U-235	.0729	PCI/G	J	.0197	.045
460	Duplicate	3 meter	99A3372-002.009	U-235	.0837	PCI/G	J	.0323	.0618
460	Real	3 meter	99A3372-002.006	U-235	.0566	PCI/G	J	.0218	.0418
460	Duplicate	Center	99A3372-002.007	U-235	.0986	PCI/G	J	.0356	.0525
460	Real	Center	99A3372-002.002	U-235	.0948	PCI/G	J	.0343	.0505
669	Duplicate	1 meter	99A4878-006.001	U-235	0.0524	PCI/G	U	0.1484	0.0835
669	Real	1 meter	99A4878-005.001	U-235	0.0457	PCI/G	U	0.178	0.0854
669	Duplicate	3 meter	99A4878-008.001	U-235	0.065	PCI/G	U	0.1896	0.0993
669	Real	3 meter	99A4878-007.001	U-235	-0.0205	PCI/G	U	0.1894	0.0231
669	Duplicate	Center	99A4878-004.001	U-235	-0.0382	PCI/G	U	0.3529	0.0431
669	Real	Center	99A4878-003.001	U-235	0.0463	PCI/G	U	0.1803	0.0865
30	Duplicate	1 meter	99A5936-005.001	U-238	0.9948	PCI/G	J	0.0786	0.2135
30	Real	1 meter	99A5936-004.001	U-238	1.1579	PCI/G		0.0651	0.2215
30	Duplicate	3 meter	99A5936-007.001	U-238	1.0056	PCI/G		0.0767	0.212
30	Real	3 meter	99A5936-006.001	U-238	1.024	PCI/G		0.1283	0.2661
30	Duplicate	Center	99A5936-003.001	U-238	2.8263	PCI/G		0.3407	0.751
30	Real	Center	99A5936-002.001	U-238	0.823	PCI/G	J	0.0925	0.211
460	Duplicate	1 meter	99A3372-002.008	U-238	2.5451	PCI/G		.0331	.2547
460	Real	1 meter	99A3372-002.004	U-238	1.9538	PCI/G		.0432	.2339
460	Duplicate	3 meter	99A3372-002.009	U-238	2.442	PCI/G		.0595	.3347
460	Real	3 meter	99A3372-002.006	U-238	2.661	PCI/G		.0479	.2875
460	Duplicate	Center	99A3372-002.007	U-238	2.2426	PCI/G		.0356	.2482
460	Real	Center	99A3372-002.002	U-238	2.4613	PCI/G		.0186	.2549
669	Duplicate	1 meter	99A4878-006.001	U-238	1.4272	PCI/G		0.0805	0.4037
669	Real	1 meter	99A4878-005.001	U-238	1.0122	PCI/G		0.1497	0.3429
669	Duplicate	3 meter	99A4878-008.001	U-238	1.3592	PCI/G		0.1421	0.3867
669	Real	3 meter	99A4878-007.001	U-238	1.0519	PCI/G		0.077	0.3389
669	Duplicate	Center	99A4878-004.001	U-238	1.1399	PCI/G		0.3145	0.4882
669	Real	Center	99A4878-003.001	U-238	1.1541	PCI/G		0.0823	0.3669

Subsurface Soil Characterization Program
Precision Results - Americium-241

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q	Det_Limit	Sigma_Error
90198	Real	98A1496-001.006	AM-241	87	PCI/G		1.09	12.2
	Replicate	98A1496-001.014	AM-241	3.93	PCI/G		0.024	0.51
90698	Real	98A1055-003.033	AM-241	1880	PCI/G		5.13	228
	Replicate	98A1055-003.036	AM-241	590	PCI/G		0.224	69.1
90798	Real	98A1055-002.019	AM-241	0.053	PCI/G	J	0.027	0.043
	Replicate	98A1055-002.020	AM-241	0.043	PCI/G	U	0.086	0.044
91298	Real	98A1055-001.010	AM-241	0.229	PCI/G	J	0.040	0.072
	Replicate	98A1055-001.011	AM-241	0.32	PCI/G		0.038	0.085
91598	Real	98A1296-001.002	AM-241	31670	PCI/G		51.5	3776
	Replicate	98A1296-001.010	AM-241	13010	PCI/G		94.6	1604
91698	Real	98A2017-001.002	AM-241	3930	PCI/G		53.2	526
	Replicate	98A2017-001.012	AM-241	4030	PCI/G		25.6	546
92498	Real	98A1502-001.002	AM-241	59.5	PCI/G		0.118	7.1
	Replicate	98A1502-001.010	AM-241	16.7	PCI/G		0.904	3.38
92698	Real	98A2022-001.004	AM-241	0.345	PCI/G		0.059	0.131
	Replicate	98A2022-001.010	AM-241	0.311	PCI/G		0.099	0.133
93098	Real	99A4353-004.002	AM-241	0.361	PCI/G		0.146	0.184
	Replicate	99A4353-005.001	AM-241	0.181	PCI/G	J	0.115	0.120
93698	Real	98A1289-001.004	AM-241	9.95	PCI/G		0.084	1.31
	Replicate	98A1289-001.010	AM-241	76.8	PCI/G		19.8	23.8
94298	Real	99A4849-004.002	AM-241	0.026	PCI/G	U	0.107	0.065
	Replicate	99A4849-005.002	AM-241	0.26	PCI/G	J	0.123	0.147
94598	Real	98A5489-001.008	AM-241	0.032	PCI/G	U	0.066	0.046
	Replicate	98A5489-001.009	AM-241	0.026	PCI/G	U	0.074	0.048
95298	Real	98A5494-001.008	AM-241	0.238	PCI/G	J	0.083	0.114
	Replicate	98A5494-001.009	AM-241	0.225	PCI/G	J	0.057	0.105
95798	Real	99A5832-004.002	AM-241	0.13	PCI/G	J	0.113	0.103
	Replicate	99A5832-005.002	AM-241	0.031	PCI/G	U	0.123	0.075
95998	Real	99A7799-006.003	AM-241	0.016	PCI/G	U	0.045	0.033
	Replicate	99A7799-009.003	AM-241	0.035	PCI/G	U	0.048	0.050
96298	Real	99A3210-004.008	AM-241	1.8	PCI/G		0.143	0.556
	Replicate	99A3210-004.009	AM-241	0.018	PCI/G	U	0.200	0.110
96798	Real	99A6650-005.003	AM-241	0.053	PCI/G	J	0.048	0.063
	Replicate	99A6650-006.003	AM-241	0	PCI/G	U	0.054	0.000
97598	Real	99A7937-004.002	AM-241	0.194	PCI/G	J	0.041	0.117
	Replicate	99A7937-005.001	AM-241	0.301	PCI/G	B	0.041	0.152
97698	Real	99A8275-001.003	AM-241	0.011	PCI/G	U	0.090	0.041
	Replicate	99A8275-006.003	AM-241	0	PCI/G	U	0.052	0.000

Subsurface Soil Characterization Program
Precision Results - Plutonium-239/240

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q	Det_Limit	Sigma_Error
90198	Real	98A1496-001.006	PU-239	711	PCI/G		6.49	99.3
	Replicate	98A1496-001.014	PU-239	20.6	PCI/G		0.016	2.41
90698	Real	98A1055-003.033	PU-239	10670	PCI/G		1.91	1249
	Replicate	98A1055-003.036	PU-239	7320	PCI/G		3.04	858
90798	Real	98A1055-002.019	PU-239	0.01	PCI/G	U	0.051	0.022
	Replicate	98A1055-002.020	PU-239	0.039	PCI/G	U	0.040	0.032
91298	Real	98A1055-001.010	PU-239	1.49	PCI/G		0.032	0.247
	Replicate	98A1055-001.011	PU-239	1.5	PCI/G		0.034	0.263
91598	Real	98A1296-001.002	PU-239	152260	PCI/G		17.8	17801
	Replicate	98A1296-001.010	PU-239	70030	PCI/G		37	8213
91698	Real	98A2017-001.002	PU-239	389	PCI/G		50.4	106
	Replicate	98A2017-001.012	PU-239	373	PCI/G		42.5	95.9
92498	Real	98A1502-001.002	PU-239	474	PCI/G		0.583	56.6
	Replicate	98A1502-001.010	PU-239	94.8	PCI/G		0.582	12.3
92698	Real	98A2022-001.004	PU-239	1.22	PCI/G		0.061	0.277
	Replicate	98A2022-001.010	PU-239	0.464	PCI/G		0.061	0.156
93098	Real	99A4353-004.002	PU-239/240	2.33	PCI/G	B	0.037	0.654
	Replicate	99A4353-005.001	PU-239/240	0.812	PCI/G		0.083	0.291
93698	Real	98A1289-001.004	PU-239	49.5	PCI/G		0.049	5.91
	Replicate	98A1289-001.010	PU-239	495	PCI/G		15.3	80.7
94298	Real	99A4849-004.002	PU-239/240	0.471	PCI/G		0.033	0.186
	Replicate	99A4849-005.002	PU-239/240	7.35	PCI/G		0.034	1.82
94598	Real	98A5489-001.008	PU-239/240	0.081	PCI/G	J	0.050	0.060
	Replicate	98A5489-001.009	PU-239/240	0.08	PCI/G	J	0.020	0.052
95298	Real	98A5494-001.008	PU-239/240	1.31	PCI/G		0.022	0.376
	Replicate	98A5494-001.009	PU-239/240	0.982	PCI/G		0.037	0.291
95798	Real	99A5832-004.002	PU-239/240	0.816	PCI/G		0.082	0.282
	Replicate	99A5832-005.002	PU-239/240	0.531	PCI/G		0.060	0.205
95998	Real	99A7799-006.003	PU-239/240	-0.019	PCI/G	U	0.102	0.023
	Replicate	99A7799-009.003	PU-239/240	0	PCI/G	U	0.041	0.000
96298	Real	99A3210-004.008	PU-239/240	1.63	PCI/G		0.070	0.492
	Replicate	99A3210-004.009	PU-239/240	0.028	PCI/G	U	0.037	0.040
96798	Real	99A6650-005.003	PU-239/240	0	PCI/G	U	0.052	0.000
	Replicate	99A6650-006.003	PU-239/240	-0.007	PCI/G	U	0.079	0.014
97598	Real	99A7937-004.002	PU-239/240	0.913	PCI/G		0.085	0.339
	Replicate	99A7937-005.001	PU-239/240	2.88	PCI/G		0.048	0.833
97698	Real	99A8275-001.003	PU-239/240	0.06	PCI/G	J	0.054	0.071
	Replicate	99A8275-006.003	PU-239/240	0.037	PCI/G	U	0.049	0.052

Subsurface Soil Characterization Program
Precision Results - Uranium-233/234

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q	Det_Limit	Sigma_Error
90198	Real	98A1496-001.006	U-234	1.58	PCI/G		0.479	0.644
	Replicate	98A1496-001.014	U-234	0.756	PCI/G	J	0.024	0.128
90698	Real	98A1055-003.033	U-234	5.14	PCI/G		2.68	2.56
	Replicate	98A1055-003.036	U-234	1.83	PCI/G	U	2.72	1.75
90798	Real	98A1055-002.019	U-234	0.859	PCI/G	J	0.015	0.121
	Replicate	98A1055-002.020	U-234	0.82	PCI/G	J	0.024	0.118
91298	Real	98A1055-001.010	U-234	0.284	PCI/G	J	0.012	0.052
	Replicate	98A1055-001.011	U-234	0.368	PCI/G	J	0.014	0.062
91598	Real	98A1296-001.002	U-234	19.8	PCI/G	U	30.6	19.1
	Replicate	98A1296-001.010	U-234	31.5	PCI/G		23.6	20.7
91698	Real	98A2017-001.002	U-234	1.83	PCI/G	U	30.1	14.0
	Replicate	98A2017-001.012	U-234	14.2	PCI/G	U	27.6	16.7
92498	Real	98A1502-001.002	U-234	0.758	PCI/G	J	0.043	0.181
	Replicate	98A1502-001.010	U-234	1.47	PCI/G		0.748	0.746
92698	Real	98A2022-001.004	U-234	0.442	PCI/G	J	0.059	0.130
	Replicate	98A2022-001.010	U-234	0.477	PCI/G	J	0.057	0.145
93098	Real	99A4353-004.002	U-233/234	0.773	PCI/G	J	0.040	0.273
	Replicate	99A4353-005.001	U-233/234	0.575	PCI/G	J	0.035	0.212
93698	Real	98A1289-001.004	U-234	0.511	PCI/G	J	0.057	0.124
	Replicate	98A1289-001.010	U-234	0.883	PCI/G	J	0.037	0.156
94298	Real	99A4849-004.002	U-233/234	0.686	PCI/G	J	0.074	0.242
	Replicate	99A4849-005.002	U-233/234	0.549	PCI/G	J	0.088	0.209
94598	Real	98A5489-001.008	U-233/234	0.802	PCI/G	J	0.019	0.232
	Replicate	98A5489-001.009	U-233/234	0.735	PCI/G	J	0.017	0.211
95298	Real	98A5494-001.008	U-233/234	0.562	PCI/G	J	0.017	0.171
	Replicate	98A5494-001.009	U-233/234	0.652	PCI/G	J	0.033	0.196
95798	Real	99A5832-004.002	U-233/234	0.654	PCI/G	J	0.068	0.228
	Replicate	99A5832-005.002	U-233/234	0.783	PCI/G	J	0.095	0.272
95998	Real	99A7799-006.003	U-233/234	0.455	PCI/G	J	0.054	0.215
	Replicate	99A7799-009.003	U-233/234	0.769	PCI/G	J	0.046	0.285
96298	Real	99A3210-004.008	U-233/234	0.656	PCI/G	J	0.038	0.239
	Replicate	99A3210-004.009	U-233/234	0.4	PCI/G	J	0.076	0.172
96798	Real	99A6650-005.003	U-233/234	0.578	PCI/G	J	0.040	0.225
	Replicate	99A6650-006.003	U-233/234	0.591	PCI/G	J	0.039	0.226
97598	Real	99A7937-004.002	U-233/234	0.978	PCI/G	J	0.042	0.327
	Replicate	99A7937-005.001	U-233/234	0.95	PCI/G	J	0.075	0.323
97698	Real	99A8275-001.003	U-233/234	0.519	PCI/G	J	0.079	0.218
	Replicate	99A8275-006.003	U-233/234	0.407	PCI/G	J	0.050	0.196

Subsurface Soil Characterization Program
Precision Results - Uranium-235

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q	Det_Limit	Sigma_Error
90198	Real	98A1496-001.006	U-235	0.384	PCI/G	U	0.514	0.34
	Replicate	98A1496-001.014	U-235	0.038	PCI/G	J	0.022	0.022
90698	Real	98A1055-003.033	U-235	0.577	PCI/G	U	2.42	1.16
	Replicate	98A1055-003.036	U-235	0.412	PCI/G	U	1.94	1.03
90798	Real	98A1055-002.019	U-235	0.035	PCI/G	J	0.009	0.015
	Replicate	98A1055-002.020	U-235	0.045	PCI/G	J	0.014	0.018
91298	Real	98A1055-001.010	U-235	0.007	PCI/G	U	0.016	0.009
	Replicate	98A1055-001.011	U-235	0.018	PCI/G	J	0.013	0.011
91598	Real	98A1296-001.002	U-235	7.2	PCI/G	U	19.8	10.8
	Replicate	98A1296-001.010	U-235	-1.748	PCI/G	U	19.2	10.2
91698	Real	98A2017-001.002	U-235	-0.913	PCI/G	U	23.2	14.0
	Replicate	98A2017-001.012	U-235	3.34	PCI/G	U	21.2	12.8
92498	Real	98A1502-001.002	U-235	0.092	PCI/G	J	0.043	0.057
	Replicate	98A1502-001.010	U-235	0.438	PCI/G	U	0.603	0.413
92698	Real	98A2022-001.004	U-235	0.022	PCI/G	U	0.049	0.029
	Replicate	98A2022-001.010	U-235	0.008	PCI/G	U	0.049	0.029
93098	Real	99A4353-004.002	U-235	0	PCI/G	U	0.050	0.000
	Replicate	99A4353-005.001	U-235	0.072	PCI/G	U	0.076	0.075
93698	Real	98A1289-001.004	U-235	0.032	PCI/G	U	0.039	0.029
	Replicate	98A1289-001.010	U-235	0.05	PCI/G	J	0.027	0.029
94298	Real	99A4849-004.002	U-235	0.034	PCI/G	U	0.091	0.059
	Replicate	99A4849-005.002	U-235	0.056	PCI/G	U	0.076	0.066
94598	Real	98A5489-001.008	U-235	0.043	PCI/G	J	0.024	0.041
	Replicate	98A5489-001.009	U-235	0.031	PCI/G	J	0.021	0.032
95298	Real	98A5494-001.008	U-235	0.023	PCI/G	J	0.021	0.028
	Replicate	98A5494-001.009	U-235	0.038	PCI/G	U	0.040	0.040
95798	Real	99A5832-004.002	U-235	0.017	PCI/G	U	0.084	0.045
	Replicate	99A5832-005.002	U-235	0.01	PCI/G	U	0.081	0.037
95998	Real	99A7799-006.003	U-235	0.21	PCI/G	J	0.117	0.162
	Replicate	99A7799-009.003	U-235	0.084	PCI/G	J	0.057	0.088
96298	Real	99A3210-004.008	U-235	0.113	PCI/G	J	0.083	0.099
	Replicate	99A3210-004.009	U-235	-0.007	PCI/G	U	0.079	0.014
96798	Real	99A6650-005.003	U-235	0.055	PCI/G	J	0.050	0.066
	Replicate	99A6650-006.003	U-235	-0.007	PCI/G	U	0.085	0.014
97598	Real	99A7937-004.002	U-235	0.077	PCI/G	J	0.052	0.080
	Replicate	99A7937-005.001	U-235	0.081	PCI/G	U	0.109	0.093
97698	Real	99A8275-001.003	U-235	0.122	PCI/G	J	0.055	0.106
	Replicate	99A8275-006.003	U-235	0.114	PCI/G	J	0.062	0.108

Subsurface Soil Characterization Project
Precision Results - Uranium-238

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q	Det_Limit	Sigma_Error
90198	Real	98A1496-001.006	U-238	1.9	PCI/G		0.546	0.716
	Replicate	98A1496-001.014	U-238	0.828	PCI/G	J	0.025	0.137
90698	Real	98A1055-003.033	U-238	7.92	PCI/G		2.42	3.1
	Replicate	98A1055-003.036	U-238	2.89	PCI/G	U	3.69	2.37
90798	Real	98A1055-002.019	U-238	0.851	PCI/G	J	0.016	0.121
	Replicate	98A1055-002.020	U-238	0.689	PCI/G	J	0.020	0.102
91298	Real	98A1055-001.010	U-238	0.319	PCI/G	J	0.020	0.057
	Replicate	98A1055-001.011	U-238	0.395	PCI/G	J	0.015	0.065
91598	Real	98A1296-001.002	U-238	28.2	PCI/G		19.8	19.2
	Replicate	98A1296-001.010	U-238	90.9	PCI/G		26.9	35
91698	Real	98A2017-001.002	U-238	0.913	PCI/G	U	32.7	14.0
	Replicate	98A2017-001.012	U-238	4.18	PCI/G	U	31.9	12.8
92498	Real	98A1502-001.002	U-238	1.1	PCI/G		0.056	0.229
	Replicate	98A1502-001.010	U-238	1.31	PCI/G		0.501	0.68
92698	Real	98A2022-001.004	U-238	0.516	PCI/G	J	0.059	0.143
	Replicate	98A2022-001.010	U-238	0.658	PCI/G	J	0.064	0.175
93098	Real	99A4353-004.002	U-238	0.645	PCI/G	J	0.072	0.242
	Replicate	99A4353-005.001	U-238	0.592	PCI/G	J	0.061	0.217
93698	Real	98A1289-001.004	U-238	0.764	PCI/G	J	0.044	0.159
	Replicate	98A1289-001.010	U-238	1.62	PCI/G		0.030	0.246
94298	Real	99A4849-004.002	U-238	0.773	PCI/G	J	0.073	0.263
	Replicate	99A4849-005.002	U-238	0.739	PCI/G	J	0.061	0.253
94598	Real	98A5489-001.008	U-238	0.813	PCI/G	J	0.019	0.235
	Replicate	98A5489-001.009	U-238	0.659	PCI/G	J	0.035	0.193
95298	Real	98A5494-001.008	U-238	0.595	PCI/G	J	0.030	0.179
	Replicate	98A5494-001.009	U-238	0.733	PCI/G	J	0.018	0.214
95798	Real	99A5832-004.002	U-238	0.792	PCI/G	J	0.067	0.260
	Replicate	99A5832-005.002	U-238	0.66	PCI/G	J	0.066	0.240
95998	Real	99A7799-006.003	U-238	1.08	PCI/G		0.094	0.379
	Replicate	99A7799-009.003	U-238	0.854	PCI/G	J	0.096	0.308
96298	Real	99A3210-004.008	U-238	1.06	PCI/G	B	0.038	0.335
	Replicate	99A3210-004.009	U-238	0.353	PCI/G	J	0.084	0.161
96798	Real	99A6650-005.003	U-238	0.52	PCI/G	J	0.083	0.212
	Replicate	99A6650-006.003	U-238	0.798	PCI/G	J	0.069	0.278
97598	Real	99A7937-004.002	U-238	0.89	PCI/G	J	0.074	0.306
	Replicate	99A7937-005.001	U-238	0.828	PCI/G	J	0.042	0.292
97698	Real	99A8275-001.003	U-238	0.5	PCI/G	J	0.078	0.213
	Replicate	99A8275-006.003	U-238	0.472	PCI/G	J	0.088	0.216

Subsurface Soil Characterization Results
QA Sample Results - VOCs

Borehole	Sample Type	RIN/Event/Bottle	Analyte	Result	Unit	Q
92598	Real	98A1092-001.036	Carbon Tetrachloride	720	UG/KG	U
	Dup	98A1092-001.037	Carbon Tetrachloride	740	UG/KG	U
95998	Real	99A7799-006.002	Carbon Tetrachloride	6.3	UG/KG	U
	Dup	99A7799-009.002	Carbon Tetrachloride	6.1	UG/KG	U
96298	Real	99A3210-004.014	Carbon Tetrachloride	670	UG/KG	U
	Dup	99A3210-004.015	Carbon Tetrachloride	700	UG/KG	U
96798	Real	99A6650-005.002	Carbon Tetrachloride	5.3	UG/KG	J
	Dup	99A6650-006.002	Carbon Tetrachloride	0.81	UG/KG	J
97698	Real	99A8275-001.002	Carbon Tetrachloride	5.3	UG/KG	U
	Dup	99A8275-006.002	Carbon Tetrachloride	5.4	UG/KG	U
97698	Real	99A8275-001.002	1,2-Cis-Dichloroethylene	5.3	UG/KG	U
	Dup	99A8275-006.002	1,2-Cis-Dichloroethylene	5.4	UG/KG	U
96798	Real	99A6650-005.002	1,2-Cis-Dichloroethylene	14.9	UG/KG	
	Dup	99A6650-006.002	1,2-Cis-Dichloroethylene	6.8	UG/KG	U
96298	Real	99A3210-004.014	1,2-Cis-Dichloroethylene	670	UG/KG	U
	Dup	99A3210-004.015	1,2-Cis-Dichloroethylene	700	UG/KG	U
95998	Real	99A7799-006.002	1,2-Cis-Dichloroethylene	79.5	UG/KG	
	Dup	99A7799-009.002	1,2-Cis-Dichloroethylene	6.1	UG/KG	U
92598	Real	98A1092-001.036	1,2-Cis-Dichloroethylene	720	UG/KG	U
	Dup	98A1092-001.037	1,2-Cis-Dichloroethylene	740	UG/KG	U
97698	Real	99A8275-001.002	Tetrachloroethene	5.3	UG/KG	U
	Dup	99A8275-006.002	Tetrachloroethene	5.4	UG/KG	U
96798	Real	99A6650-005.002	Tetrachloroethene	72.2	UG/KG	
	Dup	99A6650-006.002	Tetrachloroethene	7.8	UG/KG	
96298	Real	99A3210-004.014	Tetrachloroethene	670	UG/KG	U
	Dup	99A3210-004.015	Tetrachloroethene	700	UG/KG	U
95998	Real	99A7799-006.002	Tetrachloroethene	343	UG/KG	E
	Dup	99A7799-009.002	Tetrachloroethene	6.1	UG/KG	U
92598	Real	98A1092-001.036	Tetrachloroethene	720	UG/KG	U
	Dup	98A1092-001.037	Tetrachloroethene	740	UG/KG	U
97698	Real	99A8275-001.002	Trichloroethene	5.3	UG/KG	U
	Dup	99A8275-006.002	Trichloroethene	5.4	UG/KG	U
96798	Real	99A6650-005.002	Trichloroethene	16.1	UG/KG	
	Dup	99A6650-006.002	Trichloroethene	0.85	UG/KG	J
96298	Real	99A3210-004.014	Trichloroethene	670	UG/KG	U
	Dup	99A3210-004.015	Trichloroethene	700	UG/KG	U
95998	Real	99A7799-006.002	Trichloroethene	12.9	UG/KG	
	Dup	99A7799-009.002	Trichloroethene	6.1	UG/KG	U
92598	Real	98A1092-001.036	Trichloroethene	720	UG/KG	U
	Dup	98A1092-001.037	Trichloroethene	740	UG/KG	U

Appendix D

903 Pad *In- Situ* Models and Uncertainties

903 PAD *IN SITU* MODELS AND UNCERTAINTIES

In Situ Models

The Canberra *in situ* systems used to perform measurements at the RFETS 903 Pad project site employ the Canberra In Situ Object Counting System (ISOCS) software. This software package allows the user to calculate efficiencies for in situ quantification of defined objects using standard templates. One such template has been used to define the in situ measurement of contaminants in soils at the 903 Pad locations. This template requires the entry of various parameters which should accurately represent the actual conditions at the project site.

The template selected for this application is the circular plane source . This template requires the user to define a horizontal source size, a vertical source size, material composition and material density. In addition, the software uses detector specific physical parameters and user definable environmental parameters such as humidity, pressure and temperature. Each of these parameters has been defined in the model to represent actual conditions at 903 Pad, using existing knowledge of the site and project defined parameters. These parameter values, and the basis for selection, are described below.

Use of inappropriate values could lead to errors in *in situ* measurements. The model used for routine measurements contains the values most representative of actual conditions, however it is possible that actual measurement locations may vary from these assumed default conditions. Since it is not possible to verify all parameter values at each measurement location, default values will be used except where it is known that conditions vary significantly. An evaluation of the potential errors associated with deviation from default parameters has been performed and forms the basis of the total propagated measurement uncertainty (TMU) used when reporting *in situ* measurement results. These are also described below.

903 Pad Project ISOCS Model

Horizontal Distribution (Field of View)
As indicated above, the model selected for the 903 Pad Project (and normally used for any *in situ* soil assays) is the circular plane geometry. The circular plane is appropriate since the detector typically views a circular area which is defined by detector height above ground and the collimator employed, if any, to restrict the field of view (FOV). For this project, the field of view was defined in the Statement of Work as a 12 m diameter FOV. However, calculations performed using ISOCS showed that an "infinite field of view" for Am-241 is about 10 meters. This is due to the low energy Am-241 photon (59 keV) which is attenuated by soil, and even air, such that there is little contribution to the detector measurement at distances beyond 5 meters from the detector. Therefore, all efficiencies assumed a FOV of 10 meters diateter. In addition, the collimator used, 5 cm with a 180 degree collimation, effectively limits the FOV to 10 meters at a height of one meter.

Vertical Distribution
The distribution of contaminants vertically will impact the efficiency used. For naturally occurring radionuclides, the distribution is basically uniform throughout the top 20-30 cm of soil. However, man-made contamination will usually have a different distribution, depending on the mode of deposition. At 903 Pad locations, contamination was deposited via airborne and/or surface water releases. This results in a distribution which will tend to have higher concentrations near the surface and decreasing concentrations with depth., which may follow an exponential function. Surface soil sampling has been performed in the 903 Pad areas to determine the vertical distributions. In general, the activities are concentrated in the top 5 cm, which may contain 60-80% of the total contamination. The sampling was generally performed in 2 or 3 cm layers, therefore the distribution in the top 5 cm layer can only be subdivided into two layers, one for the top 3 cm and a second for the next 2 (or 3) cm. Based on available data, the ISOCS model assumes all contamination is contained in the top 5 cm, and it is distributed with 66% in the top 3 cm and 33% in the next 2 cm. This distribution is used to be consistent with the soil sampling protocol, which calls for sampling to a depth of two inches. In addition, the contribution from Am-241 below a depth of 5 cm in soil is quite small. This distribution, however, will skew results for naturally occurring radionuclides due to the different distributions.

Soil Composition
The chemical composition of the soils, including moisture content, will impact efficiency determinations. A number of soil samples from the 903 Pad locations have been analyzed and reported for chemical composition. The ISOCS software contains several soil models with varying elemental content. Based on the available data, a soil composition containing measurable amounts of metals, including Fe, and a small amount of H2O (low moisture content) was selected as most representative of RFETS soils. This soil model is termed "dry dirt" and has a composition of: 49O, 27Si, 4Fe, 1.6Mg, 4Ca, 7Al, 0.8Na.

Soil Density
The available soil density data from 903 Pad locations shows densities ranging from 1.0 to 1.3 g/cc. *In Situ* soil densities are typically on the order of 1.6 g/cc, but it is believed that, due to the lower moisture content of RFETS soils, this value may be too high. The ISOCS model uses a value of 1.3 g/cc as a mean value for 903 Pad soils.

Uniformity
The uniformity, or non-uniformity, of contamination, both vertically and horizontally, will impact measurement results. Based on the mode of contamination deposition and on prior survey results (including *in situ* surveys), it is believed that the contamination is relatively uniform within the field of view in the ISOCS systems. This is a reasonable assumption since the in situ measurements integrate the readings over nearly 80 sq m areas. Thus, any individual "hot spots" are averaged over the entire area, or volume, and their impacts are minimized. The ISOCS model is based on uniform distributions.

Environmental Conditions
Environmental temperature, humidity and pressure may impact some measurements. The ISOCS models assume standard environmental conditions; i.e. 20 C, 50 % relative humidity and 760 mm barometric pressure. Normal barometric pressure at RFETS is less, but the impact is negligible, as shown below.

Detector Parameters
An ISOCS efficiency for each detector has been generated, using the specific detector characteristics, which tend to remain constant for long periods of time. The parameter of concern is the detector surface dead layer, which, if it increases could effect detection of low energy photons. This can be monitored by routine check source counts using a source with a low energy photon, such as Am-241. There have been no changes to these parameters over the course of the 903 Pad Project.

The ISOCS template used for the 903 Pad ISOCS efficiency is attached.

ISOCS Model Uncertainties.

As described above, the default ISOCS models are based on assumed mean values for the given set of model parameters. It is recognized that the actual conditions may vary and that it is not possible to characterize each measurement location to use location specific values. Therefore, Canberra has attempted to bound the likely range of parameter values based on existing data, evaluate the potential errors of using mean values when compared to the likely ranges, then assign an error to each parameter and propagate a total measurement uncertainty (TMU). Each parameter has been evaluated, as shown below, and a maximum error estimated for the mean value, based on the likely range of values for a given parameter. The impact of a deviation from the mean value was assessed by entering that value into an ISOCS efficiency, then analyzing a standard count and comparing the Am-241 result to that obtained with the mean value. Each parameter was evaluated independently. The variation from the mean value was considered to be the maximum deviation and equivalent to a 3 sigma boundary.

Horizontal Distribution (Field of View)
The field of view is limited by the 180 degree collimator and the range of Am-241 photons in soil. It is assumed that the horizontal distribution is uniform. There are no likely maximum or minimum ranges for this parameter and no error estimate is provided.

Vertical Distribution
The model distribution was estimated from soil sampling data but is rather coarse. It is possible that the actual distributions in the top 5 cm may be more concentrated near the surface or more uniformly distributed throughout the 5 cm layer. A set of efficiencies with different vertical distributions were prepared and the standard acquisition analyzed.

Results:

Default 2 layer 0-3 cm 66%, 3-5 cm 33%	Am-241 = 12,2 pCi/g
Single layer, 0-5 cm uniform	Am-241 = 14.3 pCi/g
3 layers, 0-1.5cm 50%, 1.5-3 cm 30%, 3-5 cm 20%	Am-241 = 11.6 pCi/g
3 layers, default with 1cm grass cover	Am-241 = 13.2 pCi/g
2 layer with 0-3 cm 60%, 3-5 cm 40%	Am-241 = 12.2 pCi/g

The overall impact of a likely range of possible distributions is about +/- 10 %.

Soil Composition
Soil compositions were varied from dirt with little heavy metal component (Dirt 2) to soils with a significant composition of metals (Dirt 4)

Results:

Default soil; Dry Dirt (49O, 27Si, 4Fe, 1.6Mg, 4Ca, 2.7K, 7Al)	Am-241 = 12.2 pCi/g
Dirt 2 (55O, 31Si, 3Fe, 7Al)	Am-241 = 11.6 pCi/g
Dirt 4 (45O, 25Si, 12Fe, 2.5Mg, 4.1Ca, 2Mn, 8.3Al, 0.7Ti)	Am-241 = 15.4 pCi/g

The overall impact of a likely range of compositions is about +/- 25%

Soil Density
Soil densities were varied from the minimum of 1.0 to a maximum of 1,6 g/cc.

Results

Default density 1.3 g/cc	Am-241 = 12.2 pCi/g
Density 1.6 g/cc	Am-241 = 12.0 pCi/g
Density 1.0 g/cc	Am-241 = 13.8 pCi/g

The overall impact of density changes is about +/- 10 %-

Environmental Conditions
The default temperature and relative humidity are close to the ranges at RFETS but the default pressure is 20 % higher than normal barometric pressure at this altitude. However, changing the parameters to the RFETS values had no impact (same Am-241 results).

Detector Parameters
Detector characteristics have been shown to be unchanged since factory calibration by verifying response by counting a standard reference material and obtaining the correct result. There is no error assigned to this.

Propagation of Uncertainties.

All significant sources of error should be included in an assessment of total measurement uncertainty (TMU). The model uncertainties described above for vertical distribution, soil composition, soil density, etc. should be considered random errors and are propagated in quadrature. These are then added to the systematic uncertainty defined below.

Random error components, and the magnitude of the estimated 3 sigma range, excluding counting statistics, are shown as:

Horizontal distribution	negligible
Vertical distribution	+/- 10 %
Soil Composition	+/- 25%
Soil Density	+/- 10%
Environmental conditions	negligible

These are propagated as Total Random Error = (10*2+25*2+10*2)1/2
= 29%

The systematic error is primarily a calibration uncertainty and is estimated to be +/- 5%.

The Total Measurement Uncertainty (excluding counting statistics) is = 29% + 5% = 34% at the 3 sigma level.

Due to reporting requirements, this error is entered into the software as the systematic error, which is then added to the counting error to arrive at a TMU. This method may overestimate the total error slightly (the correct method would be to propagate the counting error with the other random uncertainties, then add the systematic error) but is necessary so that the software can report individual values for the counting error and the TMU.
Typical TMU values for detected Am-241 in natural background locations may range from as high as 70% for low levels (e.g. <10 pCi/g) to 40% for high levels.

Appendix E

Summary Statistics

Appendix E. Summary Statistics
Borehole Radiological Data-903 Pad and Lip Area

Asphalt					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	0.81	0.05	0.75	0.16	0.07
Geometric Mean	0.80	0.04	0.74	#N/A	0.04
Standard Error	0.05	0.01	0.04	0.13	0.03
Median	0.78	0.04	0.75	0.03	0.04
Mode	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	0.15	0.03	0.13	0.40	0.10
Sample Variance	0.02	0.00	0.02	0.16	0.01
Kurtosis	1.70	7.01	-1.60	8.85	8.28
Skewness	1.22	2.46	-0.08	2.97	2.84
Coefficient of Variation	0.19	0.72	0.17	2.42	1.46
Range	0.47	0.12	0.32	1.22	0.33
Minimum	0.66	0.01	0.60	0.00	0.02
Maximum	1.13	0.13	0.92	1.22	0.34
Sum	7.27	0.42	6.74	1.48	0.63
Count	9	9	9	9	9
Confidence Level (90.0%)	0.08	0.02	0.07	0.22	0.06

Bedrock					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	0.49	0.04	0.62	0.09	0.04
Geometric Mean	0.45	N/A	0.58	0.05	N/A
Standard Error	0.06	0.01	0.06	0.03	0.02
Median	0.43	0.05	0.69	0.04	0.03
Mode	#N/A	#N/A	#N/A	0.01	0.01
Standard Deviation	0.19	0.03	0.19	0.11	0.06
Sample Variance	0.04	0.00	0.04	0.01	0.00
Kurtosis	1.08	-0.02	0.13	1.89	3.71
Skewness	0.86	0.50	-0.96	1.69	1.51
Coefficient of Variation	0.39	0.81	0.31	1.26	1.54
Range	0.72	0.12	0.63	0.35	0.26
Minimum	0.19	-0.01	0.22	0.01	-0.05
Maximum	0.90	0.11	0.84	0.36	0.21
Sum	5.83	0.51	7.43	1.07	0.50
Count	12	12	12	12	12
Confidence Level (95.0%)	0.11	0.02	0.11	0.06	0.04
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	0	0

Appendix E. Summary Statistics
Borehole Radiological Data-903 Pad and Lip Area

Fill					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	1.06	0.09	1.15	53.75	12.01
Geometric Mean	1.02	0.06	1.00	5.78	1.18
Standard Error	0.11	0.04	0.18	45.95	10.38
Median	0.98	0.06	1.13	4.48	0.85
Mode	0.84	0.07	1.24	#N/A	#N/A
Standard Deviation	0.38	0.13	0.61	159.19	35.97
Sample Variance	0.14	0.02	0.37	25340.90	1294.08
Kurtosis	4.79	11.19	5.53	11.88	11.90
Skewness	1.51	3.30	1.72	3.44	3.44
Coefficient of Variation	0.36	1.43	0.53	2.96	2.99
Range	1.61	0.49	2.60	557.99	125.98
Minimum	0.41	0.00	0.17	0.01	0.02
Maximum	2.02	0.49	2.77	558.00	126.00
Sum	12.25	1.00	13.33	642.14	143.51
Count	12	12	12	12	12
Confidence Level (90.0%)	0.18	0.06	0.29	75.59	17.08
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	1	1

Native					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	0.51	0.04	0.63	0.27	0.11
Geometric Mean	0.49	N/A	0.60	N/A	N/A
Standard Error	0.02	0.01	0.02	0.06	0.03
Median	0.48	0.03	0.59	0.05	0.04
Mode	0.58	0.02	0.66	0.01	0.00
Standard Deviation	0.16	0.05	0.21	0.53	0.25
Sample Variance	0.02	0.00	0.04	0.28	0.06
Kurtosis	13.79	2.25	4.58	9.25	31.76
Skewness	2.74	1.65	1.72	2.94	5.20
Coefficient of Variation	0.31	1.10	0.33	2.00	2.32
Range	1.12	0.22	1.16	2.86	1.81
Minimum	0.28	-0.01	0.30	-0.02	-0.01
Maximum	1.40	0.21	1.46	2.84	1.80
Sum	36.37	3.18	45.03	19.18	7.70
Count	72	72	72	72	72
Confidence Level (95.0%)	0.04	0.01	0.05	0.12	0.06
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	0	0

Appendix E. Summary Statistics
Borehole Radiological Data-903 Pad and Lip Area

Native 1					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	5.31	0.60	16.83	3595.75	775.68
Geometric Mean	1.43	N/A	1.99	146.69	30.48
Standard Error	2.91	0.30	12.58	2462.86	514.23
Median	0.99	0.06	1.32	152.00	34.80
Mode	1.14	0.04	1.54	#N/A	#N/A
Standard Deviation	22.90	2.38	99.08	19392.56	4049.07
Sample Variance	524.52	5.65	9817.55	376071264.13	16394945.59
Kurtosis	55.37	38.00	60.51	59.32	58.16
Skewness	7.30	5.87	7.74	7.63	7.53
Coefficient of Variation	4.31	3.94	5.89	5.39	5.22
Range	177.58	17.81	779.51	152259.18	31669.85
Minimum	0.42	-0.91	0.49	0.82	0.15
Maximum	178.00	16.90	780.00	152260.00	31670.00
Sum	329.51	37.38	1043.61	222936.51	48092.47
Count	62	62	62	62	62
Confidence Level (95.0%)	5.70	0.59	24.66	4827.10	1007.87
Number of Detections Above Tier I	0	0	1	9	12
Number of Detections Above Tier II	0	0	1	27	27

Native 2					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	1.00	0.16	1.50	122.11	25.23
Geometric Mean	0.76	N/A	0.98	8.65	1.79
Standard Error	0.18	0.11	0.29	41.76	8.90
Median	0.73	0.04	0.88	7.62	1.50
Mode	1.63	0.02	0.40	#N/A	#N/A
Standard Deviation	1.42	0.83	2.32	328.85	70.12
Sample Variance	2.00	0.69	5.39	108142.37	4916.12
Kurtosis	49.56	61.25	24.30	15.58	16.02
Skewness	6.73	7.80	4.59	3.81	3.82
Coefficient of Variation	1.41	5.08	1.55	2.69	2.78
Range	11.36	6.58	15.40	1819.87	405.97
Minimum	0.04	-0.01	0.30	0.14	0.03
Maximum	11.40	6.57	15.70	1820.00	406.00
Sum	62.21	10.12	92.74	7571.08	1564.40
Count	62	62	62	62	62
Confidence Level (95.0%)	0.35	0.21	0.58	81.86	17.45
Number of Detections Above Tier I	0	0	0	2	2
Number of Detections Above Tier II	0	0	0	7	8

Appendix E. Summary Statistics
Borehole Radiological Data-903 Pad and Lip Area

Native 3					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	0.70	0.05	0.96	16.24	3.14
Geometric Mean	0.59	N/A	0.71	1.33	N/A
Standard Error	0.06	0.01	0.16	5.09	1.07
Median	0.61	0.03	0.64	0.94	0.23
Mode	0.38	0.02	0.57	0.06	0.25
Standard Deviation	0.44	0.06	1.23	40.12	8.46
Sample Variance	0.19	0.00	1.52	1609.25	71.49
Kurtosis	14.59	16.55	32.01	20.03	23.95
Skewness	3.03	3.70	5.22	4.19	4.60
Coefficient of Variation	0.63	1.23	1.28	2.47	2.69
Range	3.11	0.37	9.00	246.99	54.41
Minimum	0.01	-0.01	0.10	0.01	-0.01
Maximum	3.12	0.36	9.10	247.00	54.40
Sum	43.32	2.92	59.60	1007.14	194.71
Count	62	62	62	62	62
Confidence Level (95.0%)	0.11	0.01	0.31	9.99	2.10
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	0	1

Native 4					
Descriptive Statistic	**U233/234 (pCi/g)**	**U235 (pCi/g)**	**U238 (pCi/g)**	**Pu239/240 (pCi/g)**	**Am241 (pCi/g)**
Mean	0.58	0.03	0.64	4.97	0.90
Geometric Mean	0.54	N/A	0.59	N/A	N/A
Standard Error	0.03	0.00	0.04	1.40	0.23
Median	0.55	0.03	0.59	0.80	0.23
Mode	0.76	0.01	0.63	34.50	0.15
Standard Deviation	0.21	0.02	0.29	10.63	1.72
Sample Variance	0.04	0.00	0.08	112.97	2.95
Kurtosis	1.50	2.86	6.66	9.49	6.52
Skewness	1.03	0.19	1.96	3.04	2.67
Coefficient of Variation	0.36	0.74	0.45	2.14	1.92
Range	1.05	0.15	1.78	54.00	7.68
Minimum	0.27	-0.05	0.19	0.00	-0.05
Maximum	1.32	0.10	1.97	54.00	7.63
Sum	33.44	1.79	37.07	288.35	51.98
Count	58	58	58	58	58
Confidence Level (95.0%)	0.05	0.01	0.07	2.74	0.44
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	0	0	1

N/A Not Applicable

Appendix E. Summary Statistics
HPGe Data

HPGe Data					
Descriptive Statistic	**^{235}U (pCi/g)**	**^{238}U (pCi/g)**	**HPGe ^{241}Am (pCi/g)**	**Predicted ^{241}Am[1] (pCi/g)**	**Predicted $^{239/240}Pu$[2] (pCi/g)**
Mean	0.24	4.46	12.60	28.43	201.20
Geometric Mean	0.00	N/A	N/A	N/A	N/A
Standard Error	1.37E-03	0.02	0.38	0.45	3.00
Median	0.23	4.37	9.62	24.80	176.67
Mode	0.23	3.63	0.90	15.46	118.91
Standard Deviation	0.05	0.67	12.67	15.02	100.11
Sample Variance	2.07E-03	0.45	160.54	225.69	10021.87
Kurtosis	4.18	10.50	13.05	18.39	22.63
Skewness	-0.12	1.10	2.84	3.36	3.74
Coefficient of Variation	0.19	0.15	1.01	0.53	0.50
Range	0.51	10.04	115.36	150.48	1060.92
Minimum	0.07	1.31	0.38	14.91	115.55
Maximum	0.58	11.35	115.74	165.39	1176.47
Sum	261.72	4946.04	13985.89	31555.57	223330.46
Count	1110	1110	1110	1110	1110
Confidence Level (95.0%)	2.68E-03	0.04	0.75	0.88	5.89
Number of Detections Above Tier I	0	0	0	0	0
Number of Detections Above Tier II	0	0	48	162	183

N/A Not Applicable

[1] Predicted ^{241}Am Based on Regression Equation: $^{241}Am = 0.0022 * {}^{241}Am^2 + 1.049 * {}^{241}Am + 14.509$

[2] Predicted $^{239/240}$ Pu Based on Regression Equation: $^{239/240}Pu = 0.0243 * {}^{241}Am^2 + 6.3749 * {}^{241}Am + 113.12$

Appendix E. Summary Statistics
VOC Borehole Data

Bedrock						
Descriptive Statistic	**Carbon Tetrachloride (mg/Kg)**	**Tetrachloroethene (mg/Kg)**	**Trichloroethene (mg/Kg)**	**Chloroform[a] (mg/Kg)**	**Cis-1,2-Dichloroethene (mg/Kg)**	**Methylene Chloride (mg/Kg)**
Mean	428.37	458.71	428.85	427.25	698.57	493.06
Geometric Mean	71.75	87.43	73.06	45.48	697.70	59.10
Standard Error	117.96	122.44	117.83	118.24	13.88	151.12
Median	620.00	660.00	620.00	620.00	700.00	390.00
Mode	700.00	700.00	700.00	700.00	700.00	700.00
Standard Deviation	456.84	458.13	456.36	457.95	36.71	585.27
Sample Variance	208701.85	209885.96	208265.48	209715.19	1347.62	342541.03
Kurtosis	0.23	0.20	0.23	0.21	4.75	-0.20
Skewness	0.73	0.63	0.73	0.72	-2.05	0.96
Coefficient of Variation	1.07	1.00	1.06	1.07	0.05	1.19
Range	1497.70	1498.40	1499.11	1499.40	110.00	1699.17
Minimum	2.30	1.60	0.89	0.60	620.00	0.83
Maximum	1500.00	1500.00	1500.00	1500.00	730.00	1700.00
Sum	6425.50	6421.90	6432.79	6408.79	4890.00	7395.93
Count	15	14	15	15	7	15
Confidence Level (95.0%)	231.19	239.98	230.95	231.75	27.19	296.18
Number of Detections Above Current Tier I SSAL	0	0	0	0	0	0
Number of Samples at 10% of Current Tier I SSAL	1	1	1	0	0	6
Number of Detections Above Proposed Tier I SSAL	0	0	0	0	0	2
Number of Detections Above Proposed Tier II SSAL	0	0	0	0	0	4
Number of Non Detections	13	12	13	10	7	7
Number of Detections	2	2	2	5	0	8

Appendix E. Summary Statistics
VOC Borehole Data

Native						
Descriptive Statistic	**Carbon Tetrachloride (mg/Kg)**	**Tetrachloroethene (mg/Kg)**	**Trichloroethene (mg/Kg)**	**Chloroform[a] (mg/Kg)**	**Cis-1,2-Dichloroethene (mg/Kg)**	**Methylene Chloride (mg/Kg)**
Mean	351.59	438.75	344.72	351.36	838.40	385.12
Geometric Mean	47.84	51.01	47.91	40.84	742.11	36.97
Standard Error	50.73	94.02	50.33	50.76	148.57	60.20
Median	6.00	24.80	6.30	6.20	700.00	5.90
Mode	5.30	5.30	5.30	700.00	700.00	5.30
Standard Deviation	427.48	797.76	424.12	427.68	742.86	507.21
Sample Variance	182742.10	636420.43	179878.11	182907.29	551839.00	257264.17
Kurtosis	-0.37	35.93	-0.24	-0.37	24.87	-0.12
Skewness	0.82	5.21	0.87	0.82	4.98	1.06
Coefficient of Variation	1.22	1.82	1.23	1.22	0.89	1.32
Range	1494.90	6099.22	1497.00	1499.36	3790.00	1699.41
Minimum	5.10	0.78	3.00	0.64	610.00	0.59
Maximum	1500.00	6100.00	1500.00	1500.00	4400.00	1700.00
Sum	24962.60	31589.97	24475.40	24946.28	20960.00	27343.80
Count	71	72	71	71	25	71
Confidence Level (95.0%)	99.43	184.27	98.65	99.48	291.19	117.98
Number of Detections Above Current Tier I SSAL	0	0	0	0	0	0
Number of Samples at 10% of Current Tier I SSAL	0	6	5	0	1	25
Number of Detections Above Proposed Tier I SSAL	0	1	0	0	0	8
Number of Detections Above Proposed Tier II SSAL	0	7	1	0	1	18
Number of Non Detections	70	55	66	64	24	36
Number of Detections	1	17	5	7	1	35

Appendix E. Summary Statistics
VOC Borehole Data

All						
Descriptive Statistic	**Carbon Tetrachloride (mg/Kg)**	**Tetrachloroethene (mg/Kg)**	**Trichloroethene (mg/Kg)**	**Chloroform[a] (mg/Kg)**	**Cis-1,2-Dichloroethene (mg/Kg)**	**Methylene Chloride (mg/Kg)**
Mean	364.98	442.00	359.40	364.59	807.81	403.95
Geometric Mean	51.34	55.69	51.57	41.62	732.16	40.12
Standard Error	46.47	80.96	46.19	46.51	116.05	56.03
Median	6.25	56.35	6.80	6.25	700.00	13.85
Mode	5.30	700.00	5.30	700.00	700.00	5.30
Standard Deviation	430.96	750.84	428.33	431.29	656.46	519.60
Sample Variance	185726.80	563753.37	183468.61	186010.08	430940.22	269980.52
Kurtosis	-0.33	37.87	-0.23	-0.34	31.79	-0.16
Skewness	0.79	5.21	0.83	0.79	5.63	1.03
Coefficient of Variation	1.18	1.70	1.19	1.18	0.81	1.29
Range	1497.70	6099.22	1499.11	1499.40	3790.00	1699.41
Minimum	2.30	0.78	0.89	0.60	610.00	0.59
Maximum	1500.00	6100.00	1500.00	1500.00	4400.00	1700.00
Sum	31388.10	38011.87	30908.19	31355.07	25850.00	34739.73
Count	86	86	86	86	32	86
Confidence Level (95.0%)	91.08	158.69	90.53	91.15	227.45	109.82
Number of Detections Above Proposed Tier I SSAL	0	1	0	0	0	10
Number of Detections Above Proposed Tier II SSAL	0	7	1	0	1	22
Number of Non Detections	83	67	79	74	31	43
Number of Detections	3	19	7	12	1	43
Number of DLs Above Proposed Tier I[b] SSAL	0	0	0	0	0	21
Number of DLs Above Proposed Tier II[b] SSAL	39	37	38	39	31	24

[a] Denotes that analyte has been omitted as a COC due to detections in the laboratory blanks
[b] Includes only non detections
DL Detection Limit

Appendix F Is Unavailable

There are five Rocky Flats Reading Rooms in the Denver metro area. Their addresses are below.

These rooms contain a huge selection of documents produced by Rocky Flats over the years, from environmental studies and reports to statistics on budgets and employment. The main reading room is located at Front Range Community College and is the most current and comprehensive. For more information, call the Front Range Community College Reading Room at (303) 469-4435.

The five Rocky Flats Reading Rooms locations are as follows:

Front Range Community College
3645 W. 112th Ave.
Westminster, CO 80030
(303) 469-4435

Rocky Flats Citizens Advisory Board
9035 N. Wadsworth Parkway, Suite 2250
Westminster, CO 80021
(303) 420-7855

Colorado Department of Public Health & Environment
4300 Cherry Creek Dr. South, Bldg. A-1
Denver, CO 80222-1530
(303) 692-2037

U.S. Environmental Protection Agency
Superfund Records Center
999 18th Street, Suite 500
Denver, CO 80202-2466

Standley Lake Library
8485 Kipling Street
Arvada, CO 80005
(303) 456-0806

Appendix G

SW053 Wetland Sediment Sampling Results

INTRODUCTION

This appendix summarizes the sediment sampling results from the small wetland area surrounding surface water sampling location 053 (SW053). This document provides the analytical results of sediment samples and field quality assurance samples collected during the investigation in support of the Characterization of 903 Pad Drum Storage Area, 903 Lip Area, and Americium Zone. The wetland is located in the southeast Americium Zone near the East Firing Range. Figure 1 provides the location of the wetland and locations where sediment samples were collected. Samples were collected at three locations: 090100, 090200, and 090300. Two sediment samples were collected at each location from the 0-6 inch and 6-12 inch depth intervals for a total of six sediment samples. Two quality assurance samples were generated in support the sampling program.

FIELD METHODS

The Final Sampling and Analysis Plan (SAP) for the Site Characterization of the 903 Drum Storage Area (IHSS 112), 903 Lip Area (IHSS 155) and Americium Zone, Rev.1 (RMRS, 1998) provided sampling requirements for characterization of the wetland. Operations Order (OO) OO-903-01, Sediment Sample Collection, was followed for the collection of samples. Hand held sampling equipment utilized to obtain sediment samples consisted of a slide hammer and core-barrel. Sediment samples were obtained by driving a core barrel 1.5 feet into the sediment and extracting the recovered material from the core barrel. Samples were generated from 6-inch intervals according to the SAP. Samples were shipped to the laboratory for analytical determination of radionuclides. Sampling equipment was decontaminated prior to sampling and in between the collection of individual samples in accordance with 4-S01-ENV-OPS-FO.03, Field Decontamination Operations.

LABORATORY METHODS

Analytical services were provided through Kaiser-Hill Analytical Services Division (ASD) using Statements Of Work (SOW) which are composed of several modules, a limited number of which are required for performing work in a specific analytical discipline. The SOW for Analytical Measurements, General Laboratory Requirements (GR01), defines requirements for the determination of organic, metal, water quality, radiochemical, geotechnical, industrial hygiene, bioassay, and other parameters in samples collected at or related to the Site. Parameter Specific Analytical (PSA) Modules provide technical requirements, quality control procedures, and analysis structure for obtaining data of known and documented quality. Modules used in support of this characterization are provided in Table 1.

Table 1. Laboratory Statement of Work Modules

Module Title	Module ID
General Laboratory Requirements	GR01
Electronic Data Deliverables	GR02
Radiochemistry Isotopic Determinations by Alpha Spectrometry	RC01

Radiochemistry Isotopic Determinations by Alpha Spectrometry

Samples collected from the wetland were submitted to laboratories for radiochemical analysis and analyzed in compliance with PSA Module Radiochemistry Isotopic Determinations by Alpha Spectrometry (RC01). The Radiochemistry Isotopic Determinations by Alpha Spectrometry SOW describes the processes by which isotopic analyses using alpha spectrometry meet the defined data quality objectives. This module requires a variety of activities that represent the minimum QA/QC operations necessary to satisfy the analytical requirements associated with the determination of the alpha-emitting radionuclides by alpha spectrometry. These operations and those in the General Laboratory Requirements Module (GR01) are designed to ensure the generation of comparable data from all laboratories contracted by ASD. Module GR02, Electronic Data Deliverables, ensures laboratories report data in a consistent format compatible with the Site's environmental databases.

QUALITY ASSURANCE

Field Quality Assurance

Two QA samples were collected in the field that included a sediment replicate sample and an equipment rinsate sample. The sample replicate was collected to qualitatively evaluate field sampling and measurement precision. The equipment rinsate sample was collected to evaluate whether the field sampling equipment was adequately decontaminated between sampling events.

Replicate Sample

One field replicate sample (00D0686-007.001) was collected from sampling location 090200 from the 0-6 inch depth interval and submitted for radiochemical analysis. The replicate sample was collected as a unique sample. The replicate and real samples were generated for alpha spectroscopy analysis by splitting the recovered core in half lengthwise over the sample interval. The single replicate sample generated met the required frequency of one replicate sample per 20 real samples required in the SAP. Figure 2 provides a comparison between real and replicate radiochemical results. As shown in Figure 2, the relative difference between real and associated replicate sample results for uranium are minimal. The relative difference between sample results is greater for americium-241 (3.8 pCi/g); the largest relative difference was observed for plutonium-239/240 at approximately 17.6 pCi/g.

The variability between field replicate samples and associated real samples is a measure of all variance introduced from sample collection in the field through radiochemical analysis. One source of variance may be attributed to an increased error associated with analyzing only an aliquot of the sample instead of measuring the bulk sample. Another source of variance between field replicates and their associated real samples is contaminant heterogeneity in the soil. Although a variance exists between sample results, the calculated sum of ratios for both real and replicate sample results are significantly below RFCA Tier II soil action levels for this sample interval and does not impact project decisions.

Equipment Rinsate Sample

One equipment rinsate sample (00D0687-001.002) was collected for radiochemical analysis. All radionuclides, with the exception of plutonium-239/240, were below the method detection limit. Plutonium-239/240 was detected at 0.07 pCi/L in the rinsate sample. This indicates that there was a potential for cross-contamination of plutonium-239/240 between samples from field-decontaminated sampling equipment. However, this magnitude of cross-contamination is very small when compared to actual sediment sample results and RFCA action levels and therefore all sample results were evaluated as actual detections in sediments.

Laboratory Quality Assurance

Specific laboratory QA samples analyzed in support of this module include laboratory duplicates and laboratory control samples to access laboratory precision and accuracy, respectively. In addition, sample results were verified and validated. Verification is an assessment process to ensure that data meet certain specified criteria. Verification is a graded process to assess both compliance of the data package with the SOW and acceptability of the data, using Parameter Specific Analytical (PSA) Module, Verification and Validation Guidelines.

Validation is a more thorough assessment process than verification. Verification and validation criteria are generally based on government-published standards and guidelines, primarily EPA CLP and SW-846 method guidelines for organic and inorganic data evaluation and review. Validation involves the inspection of data package contents for both compliance with the SOW and validity of the data, using PSA Module verification and validation guidelines. Validation includes examination of raw data and calculations.

Laboratory Data Validation

All sample results generated from the laboratory analysis of sediment samples underwent validation. Section 3.2, Laboratory Data Assessment, Verification, and Validation, provides detailed information on the Site's quality assurance evaluation of analytical data. All data reported from sediment samples were validated as "*no problems with the data were observed at the indicated review level*" ("V").

Laboratory Precision Results

Laboratory duplicate samples were analyzed for radiochemical parameters to measure laboratory precision. Laboratory duplicates samples were run at a frequency of one set of QC samples per 10 field samples or a minimum of one set per analytical batch. Verification and validation guidelines require that all data generated in an analytical batch in which the laboratory duplicate did not meet required criteria to validated as "*estimated*" ("J") or as "*the results could be considered estimated at an elevated level of detection*" ("UJ"). All radiochemical data met the laboratory validation criteria ("V").

Laboratory Accuracy

Accuracy is a measure of how closely an analytical result corresponds to the true concentration or activity in a sample. Laboratory accuracy for radiochemical analysis was evaluated by analyzing laboratory control samples (LCS). LCSs were analyzed at the required frequency of one per analytical batch. All LCS results were within the control limits (75% - 125%).

NATURE AND EXTENT OF CONTAMINIATION

<u>Field Sampling Results</u>

The three sediment samples were collected roughly in a triangular grid with location 090100 closest to the seep at SW053 (Figure 1). Samples were collected on December 27, 1999; a thin layer of ice covered the wetland at the time of sampling. Location 090200 was collected directly south of 090100. Sediment sampling location 090300 was collected northeast of 090100 (Figure 1). Actual sediment samples were recovered at two of the sampling locations (090100 and 090200). Approximately 1.15 feet of peat and sandy clay overly the weathered bedrock at sampling location 090100. Borehole logs are provided as an attachment. Clayey sand and silty sand were recovered to 1 foot in depth at sampling location 090200. The boring was completed to 1.5 feet in depth, bedrock was not encountered at this location, Only weathered bedrock was encountered at sampling location 090300; no sediment was present at this location.

Two weathered bedrock samples were generated at this sampling location and submitted to the laboratory for radiochemical determination.

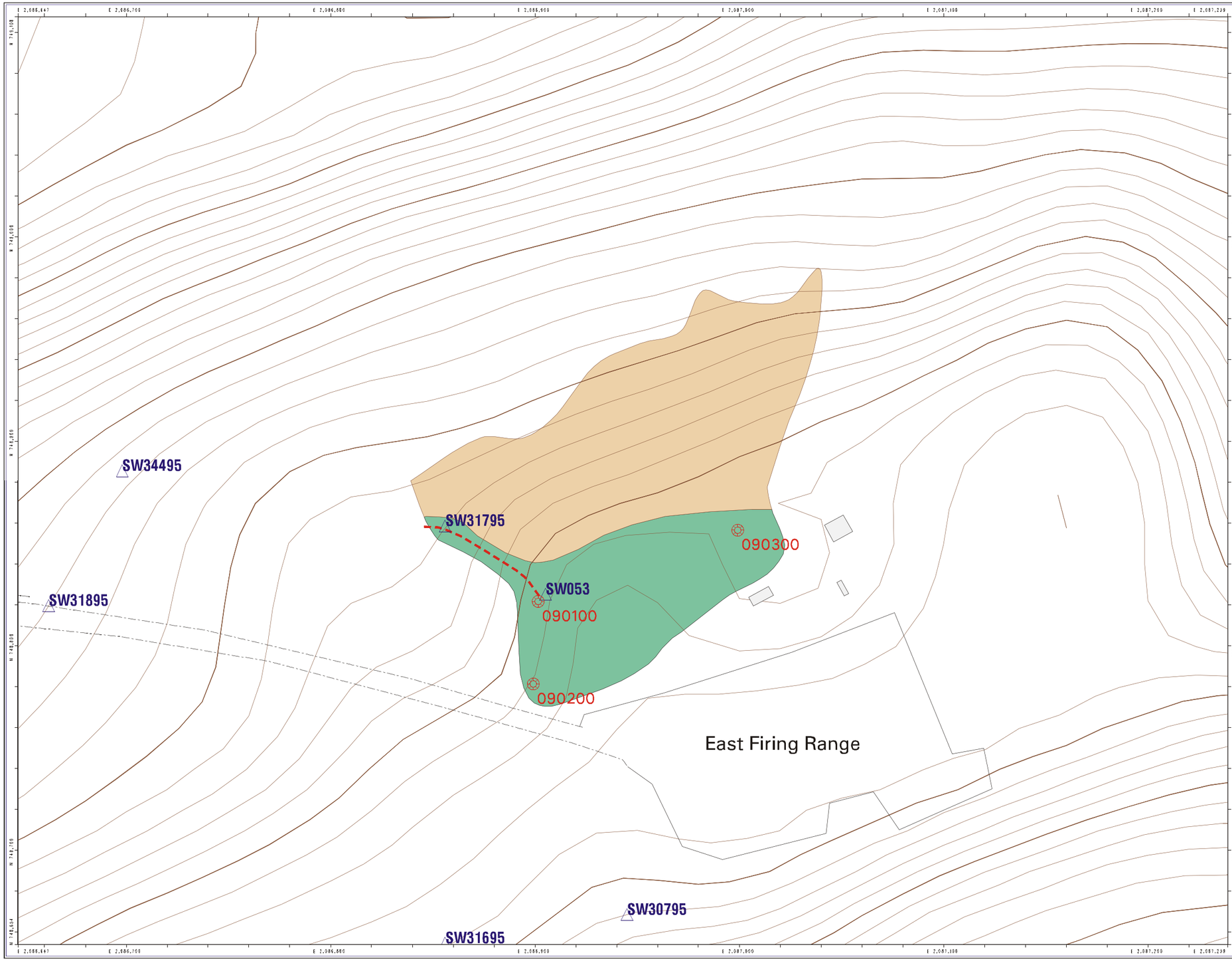
Sediment Sample Analytical Results

This section presents sediment sample results as compared to background surface soil activities, which are defined as the mean plus two standard deviations. Analytical results were also compared to RFCA Tier I and II surface soil action levels (individual radionuclide action levels). Background surface soil activities are provided in the *Geochemical Characterization of Background Surface Soil: Background Soil Characterization Program (EG&G, 1995).*

Americium-241 results in sediments ranged from 0.188 to 31.3 pCi/g. These results are above background concentrations (0.022 pCi/g) and are slightly less than the Tier II soil action level of 38 pCi/g. Plutonium-239/240 results ranged from 0.298 to 182 pCi/g. These activities are also above background activities but below the Tier II soil action level of 252 pCi/g for plutonium-239/240. Activities of uranium-233/234 in sediments ranged from 0.727 up to 2.44 pCi/g. The maximum activity of uranium-233/234 slightly exceeded the background activity of 2.25 pCi/g. Uranium-235 activities ranged from 0.01 to 0.93 pCi/g, with the maximum detectable activity slightly below the background activity of 0.094 pCi/g. Uranium-238 activities ranged from 0.752 to 2.2 pCi/g. The maximum uranium-238 activity slightly exceeded the background activity of 2.00 pCi/g. Table 2 provides analytical results of sediment and QA samples.

CONTAMINATED MEDIA RESULTS

One sediment sample from the 0-6 inch interval at location 090100 exceeded the Tier II soil action level using the sum of ratios methodology. This sampling location is closest to the seep at SW053 which is also a depositional area for storm generated surface water runoff from the northwest. No samples exceeded Tier I soil action levels (Table 2).



Characterization Report for the
903 Pad Drum Storage Area,903 Lip Area
and Amercium Zone

Wetland Area Sediment Sampling Locations Figure 1

EXPLANATION

Surface Water Sampling Location

Approximate Soil Boring Location

Wetland Features

Wetland (Ephemeral Spring)

Hummocky Topography (Landslide)

Drainage

Standard Map Features

Buildings and other structures

Solar Evaporation Ponds (SEP)

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Contour (2-Foot)

Paved roads

Dirt roads

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 2-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Data Source:
Sampling Locations - Approved by RMRS Water Program Group, POC Steve Singer, 303-966-3387.
Wetland Features - Approved by RMRS, POC Mark Wood, 303-966-6689.
Source: Dec. 27, 1999 sampling event, visual estimate of locations.

Scale = 1 : 590
1 inch represents approximately 49 feet

10 0 20 40ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:

MAP ID: 2k-0285/wetland.aml

July 20, 2000

NT_Svr w:/projects/fy2k/2k-0285/wetland.aml

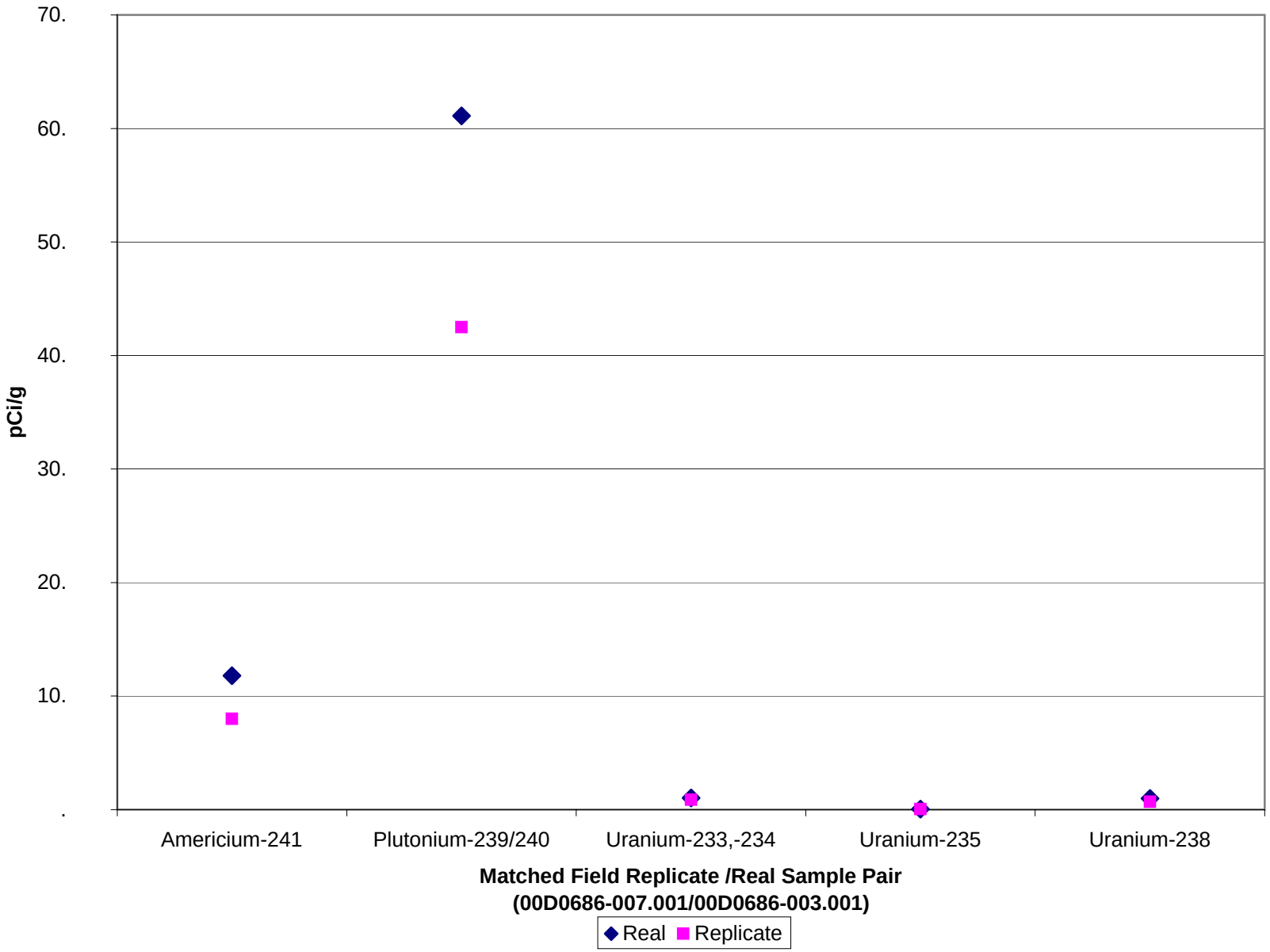


Figure 2 Matched Field Replicate/Real Sample Pair From Location 90200 0-6 Inch Depth

Table 2. Analytical Results of Sediment Samples Collected at SW053 Wetland

LOCATION	SAMPLE INTERVAL (in.)	SAMPLE TYPE	SRT_BOTTLE_NUM	RESULT TYPE	DESCRIPTION	RESULT	UNIT	Q	V	Tier I SOR	Tier II SOR
090100	0-6	Real	00D0686-001.002	TR1	AMERICIUM-241	31.3	PCI/G		V		
090100	0-6	Real	00D0686-001.002	TR1	PLUTONIUM-239/240	182	PCI/G		V		
090100	0-6	Real	00D0686-001.002	TR1	URANIUM-233,-234	2.44	PCI/G		V		
090100	0-6	Real	00D0686-001.002	TR1	URANIUM-235	0.093	PCI/G	J	V		
090100	0-6	Real	00D0686-001.002	TR1	URANIUM-238	2.2	PCI/G		V	0.28	1.57
090100	6-12	Real	00D0686-002.002	TR1	AMERICIUM-241	0.356	PCI/G		V		
090100	6-12	Real	00D0686-002.002	TR1	PLUTONIUM-239/240	2.66	PCI/G		V		
090100	6-12	Real	00D0686-002.002	TR1	URANIUM-233,-234	0.85	PCI/G	J	V		
090100	6-12	Real	00D0686-002.002	TR1	URANIUM-235	0.07	PCI/G	U	V		
090100	6-12	Real	00D0686-002.002	TR1	URANIUM-238	0.752	PCI/G	J	V	0.01	0.03
090200	0-6	Real	00D0686-003.002	TR1	AMERICIUM-241	11.8	PCI/G		V		
090200	0-6	Real	00D0686-003.002	TR1	PLUTONIUM-239/240	61.1	PCI/G		V		
090200	0-6	Real	00D0686-003.002	TR1	URANIUM-233,-234	1.03	PCI/G	B	V		
090200	0-6	Real	00D0686-003.002	TR1	URANIUM-235	0.035	PCI/G	U	V		
090200	0-6	Real	00D0686-003.002	TR1	URANIUM-238	0.987	PCI/G	J	V	0.10	0.57
090200	0-6	Replicate	00D0686-007.001	TR1	AMERICIUM-241	8	PCI/G		V		
090200	0-6	Replicate	00D0686-007.001	TR1	PLUTONIUM-239/240	42.5	PCI/G		V		
090200	0-6	Replicate	00D0686-007.001	TR1	URANIUM-233,-234	0.882	PCI/G	J	V		
090200	0-6	Replicate	00D0686-007.001	TR1	URANIUM-235	0.034	PCI/G	U	V		
090200	0-6	Replicate	00D0686-007.001	TR1	URANIUM-238	0.688	PCI/G	J	V	0.07	0.39
090200	6-12	Real	00D0686-004.002	TR1	AMERICIUM-241	0.188	PCI/G	J	V		
090200	6-12	Real	00D0686-004.002	TR1	PLUTONIUM-239/240	0.298	PCI/G	J	V		
090200	6-12	Real	00D0686-004.002	TR1	URANIUM-233,-234	0.727	PCI/G	J	V		
090200	6-12	Real	00D0686-004.002	TR1	URANIUM-235	0.068	PCI/G	J	V		
090200	6-12	Real	00D0686-004.002	TR1	URANIUM-238	0.855	PCI/G	J	V	0.00	0.02

Q - Laboratory Qualification
V - Validation/Validated
SOR - Sum of Ratios

Table 2. Analytical Results of Sediment Samples Collected at SW053 Wetland

LOCATION	SAMPLE INTERVAL (in.)	SAMPLE TYPE	SRT_BOTTLE_NUM	RESULT TYPE	DESCRIPTION	RESULT	UNIT	Q	V	Tier I SOR	Tier II SOR
090300	0-6	Real	00D0686-005.002	TR1	AMERICIUM-241	5.06	PCI/G		V		
090300	0-6	Real	00D0686-005.002	TR1	PLUTONIUM-239/240	30	PCI/G		V		
090300	0-6	Real	00D0686-005.002	TR1	URANIUM-233,-234	1.13	PCI/G	B	V		
090300	0-6	Real	00D0686-005.002	TR1	URANIUM-235	0.01	PCI/G	U	V		
090300	0-6	Real	00D0686-005.002	TR1	URANIUM-238	1.29	PCI/G		V	0.05	0.27
090300	6-12	Real	00D0686-006.002	TR1	AMERICIUM-241	0.295	PCI/G	J	V		
090300	6-12	Real	00D0686-006.002	TR1	PLUTONIUM-239/240	1.1	PCI/G		V		
090300	6-12	Real	00D0686-006.002	TR1	URANIUM-233,-234	1.05	PCI/G	B	V		
090300	6-12	Real	00D0686-006.002	TR1	URANIUM-235	0.035	PCI/G	U	V		
090300	6-12	Real	00D0686-006.002	TR1	URANIUM-238	0.964	PCI/G	J	V	0.00	0.02
090300		Rinsate	00D0687-001.002	TR1	AMERICIUM-241	0.008	PCI/L	U	UJ		
090300		Rinsate	00D0687-001.002	TR1	PLUTONIUM-239/240	0.07	PCI/L		V		
090300		Rinsate	00D0687-001.002	TR1	URANIUM-233,-234	0.002	PCI/L	U	V		
090300		Rinsate	00D0687-001.002	TR1	URANIUM-235	-0.001	PCI/L	U	V		
090300		Rinsate	00D0687-001.002	TR1	URANIUM-238	-0.015	PCI/L	U	V	NA	NA

Q - Laboratory Qualification
V - Validation/Validated
SOR - Sum of Ratios

ATTACHMENT

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 1

Borehole Number: 59 90100 (mw 2/15/00)
Location - North: _____ East: _____
Date: 12/27/99
Geologist: M. Wood
Drilling Equip.: slide hammer

Surface Elevation: _____
Area: Am Zone
Total Depth: 1.55
Company: RMRS
Project No.: _____
Sample Type: tube

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/26/00

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/ LITHOLOGIC LOG	SAMPLE DESCRIPTION
RIN 00D0886			001.001 001.002				pt			0.0 - 0.45 Peat w/some silt/clay dk gray, very soft, saturated
			002.001 002.002				MH	0.5		0.45 - 0.66' Silt, MH, w/some f-m sand dk gray to black (N1) v. soft, saturated
							ML/CL	1.0		0.66 - 1.15 sandy clay Sandy Silt ~ colluvium or bedrock ~ siltstone/claystone highly weathered, some roots firm
								1.5		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 1

Borehole Number: ~~SEB~~ 90200 (MW 6/19/00)
Location - North: _____ East: _____
Date: 12/27/99
Geologist: M. Weed
Drilling Equip. Slide Hammer

Surface Elevation: _____
Area: 903 Lip Area / Am Zone
Total Depth: _____
Company: RMRS Project No. _____
Sample Type: tube / grab

RMRS LOGGING SUPERVISOR
APPROVAL [signature] DATE 6/26/00

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/ LITHOLOGIC LOG	SAMPLE DESCRIPTION
LIN	00D0686		903.001				OH			0.0 - 0.3 Sandy Clay (OH) dark gray very soft ab roots very plastic, saturated
			903.002							
			007.001							
								0.5		0.3 - 1.0 Sandy Silt (MH) orange brown, loose to soft, plastic, some roots, trace f gravel thin 1cm sand interbeds, saturated
			004.001							
			004.002				MH			
								1.0		
								1.5		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

14011-930-0154-930X Form GT 1A (03/01; V2)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 1

Borehole Number: SED90300
Location - North: 6174700 East:
Date: 12/27/99
Geologist: M. Ward
Drilling Equip. Slide hammer

Surface Elevation:
Area: 903 Lip Area / Am Zone
Total Depth: 2.2 ft
Company: RMRS Project No.:
Sample Type: tube / grab

RMRS LOGGING SUPERVISOR
APPROVAL [signature] DATE 6/26/00

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
RIND			005.001				CL/			0.0 - 0.8 claystone/CL
OOD0686			005.002				BR			dark gray - olive gray, crots,
										soft, friable, plastic, saturated
			006.001					0.5		becomes blocky at 0.5 ft,
			006.002				claystone			
								1.0		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

(4011-930-0134-930)(Form GT 1A x03/01/92)